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## Note-Taking Tips

Your notes are a reminder of what you learned in class. Taking good notes can help you succeed in science. The following tips will help you take better classroom notes.

- Before class, ask what your teacher will be discussing in class. Review mentally what you already know about the concept.
- Be an active listener. Focus on what your teacher is saying. Listen for important concepts. Pay attention to words, examples, and/or diagrams your teacher emphasizes.
- Write your notes as clearly and concisely as possible. The following symbols and abbreviations may be helpful in your note-taking.

Word or Phrase	Symbol or Abbreviation	Word or Phrase	Symbol or Abbreviation
for example	e.g.	and	+
such as	i.e.	approximately	$\approx$
with	w/	therefore	$\therefore$
without	w/o	versus	vs

- Use a symbol such as a star (★) or an asterisk (\*) to emphasize important concepts. Place a question mark (?) next to anything that you do not understand.
- Ask questions and participate in class discussion.
- Draw and label pictures or diagrams to help clarify a concept.
- When working out an example, write what you are doing to solve the problem next to each step. Be sure to use your own words.
- Review your notes as soon as possible after class. During this time, organize and summarize new concepts and clarify misunderstandings.

## Note-Taking Don'ts

- **Don't** write every word. Concentrate on the main ideas and concepts.
- **Don't** use someone else's notes. They may not make sense.
- **Don't** doodle. It distracts you from listening actively.
- **Don't** lose focus or you will become lost in your note-taking.



# 1 The Nature of Science

## ENCOUNTER THE PHENOMENON

Write the Encounter the Phenomenon question for this module.

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Use the “What I Know” column to list the things you know about the Encounter the Phenomenon question. Then list the questions you have about the Encounter the Phenomenon question in the “What I Want to Find Out” column. As you read the module, fill in the “What I Learned” column.

K <i>What I Know</i>	W <i>What I Want to Find Out</i>	L <i>What I Learned</i>

# The Nature of Science

## 1 The Methods of Science

### REVIEW VOCABULARY

investigation

Recall the definition of the Review Vocabulary term.

investigation

### NEW VOCABULARY

scientific methods

hypothesis

experiment

variable

dependent variable

independent variable

constant

control

bias

model

theory

scientific law

Use your book to define each term.

scientific methods

hypothesis

experiment

variable

dependent variable

independent variable

constant

control

bias

model

theory

scientific law

## 1 The Methods of Science (continued)

### Main Categories of Science

- Life science = study of life
- Earth science = study of Earth and space
- Physical science = study of matter and energy

### Scientific Methods

- State the problem
- Gather information
- Form a hypothesis
- Test the hypothesis
- Analyze data
- Draw conclusions

**Identify** the three main categories of science. Summarize the topic studied in each category.

1. \_\_\_\_\_
2. \_\_\_\_\_
3. \_\_\_\_\_

**Get It? Identify** What is the first step in a scientific investigation, and what form does it usually take?

---

---

**Sequence** the scientific methods in the most typical order. The first step has been completed for you.

- |                      |          |
|----------------------|----------|
| 1. State the problem | 4. _____ |
| 2. _____             | 5. _____ |
| 3. _____             | 6. _____ |

**Get It? Identify** What is the purpose of a control in an experiment?

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**Summarize** the steps a scientist might take to determine if a new drug works in cancer patients.

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## 1 The Methods of Science (continued)

**Get It? Define** What is bias in science?

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**Organize** the advantages and disadvantages of a pilot flying a real airplane and flying a simulator.

	Advantages	Disadvantages
Real airplane		
Simulator		

### Scientific Theories and Laws

- Scientific laws are descriptions of what happens in nature and seems to always be true
- Scientific theories are explanations based on many observations and investigations

**Distinguish** between a scientific theory and a scientific law.

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## 1 The Methods of Science (continued)

**Complete** the following paragraph about the limitations of science.

Science \_\_\_\_\_ explain or solve everything. A scientist has to make sure his or her guesses can be \_\_\_\_\_ and \_\_\_\_\_. Science cannot answer questions about \_\_\_\_\_ and \_\_\_\_\_. For example, a(n) \_\_\_\_\_ of people's opinions about such questions would not prove that the opinions are true for everyone.

### CHECK YOUR PROGRESS

- 1. Define** Summarize the steps you might use to carry out an investigation using scientific methods.

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- 2. Explain** what a law is, what a theory is, and why a theory cannot become a law.

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- 3. Analyze** What is the dependent variable in an experiment that shows how the volume of a gas changes with changes in temperature?

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- 4. Math Connection** An experiment to determine how many breaths a squirrel takes per minute yields this data: minute 1: 65 breaths; minute 2: 73 breaths; minute 3: 67 breaths; minute 4: 71 breaths; minute 5: 62 breaths. Calculate the average number of breaths per minute.

---

# The Nature of Science

## 2 Standards of Measurement

### REVIEW VOCABULARY

measurement

### NEW VOCABULARY

standard

SI

volume

matter

mass

density

Recall the definition of the Review Vocabulary term.

measurement

Use your book to define each term.

standard

SI

volume

matter

mass

density

Summarize why measurement standards are necessary.

### SI (International System of Units)

- From French "Système Internationale d'Unités"
- 7 base units: m, kg, s, A, K, mol, cd
- Units can be modified by prefixes: milli-, kilo-, etc.
- Derived units come from two or more base units

Complete the table of SI base units used to measure various quantities.

Quantity Measured	Unit	Symbol
Time		s
	kilogram	
		K
	candela	
Length		
	mole	
		A

## 2 Standards of Measurement (continued)

### Volume

- Amount of space occupied by an object
- For a rectangular solid,  
 $\text{volume} = \text{length} \times \text{width} \times \text{height}$

**Get It? Calculate** How many meters is 1 km? How many grams is 1 dg?

---

**Create** an example of a real-world object that could be appropriately measured using each of these units of length.

meter 

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kilometer 

---

millimeter 

---

micrometer 

---

**Organize** the steps for finding the volume of a rectangular solid by listing them below.

---

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**Complete** the table below. Place an X in the appropriate box to indicate the type of each measurement unit.

Measurement	SI Unit	Derived Unit
gram per centimeter cubed ( $\text{g}/\text{cm}^3$ )		
milliampere (mA)		
liter (L)		
cubic meter ( $\text{m}^3$ )		
kilogram (kg)		

## 2 Standards of Measurement (continued)

### Mass and Density

- Mass is a measurement of the quantity of matter
- Density is mass per unit volume.  $D = m/V$

### Temperature

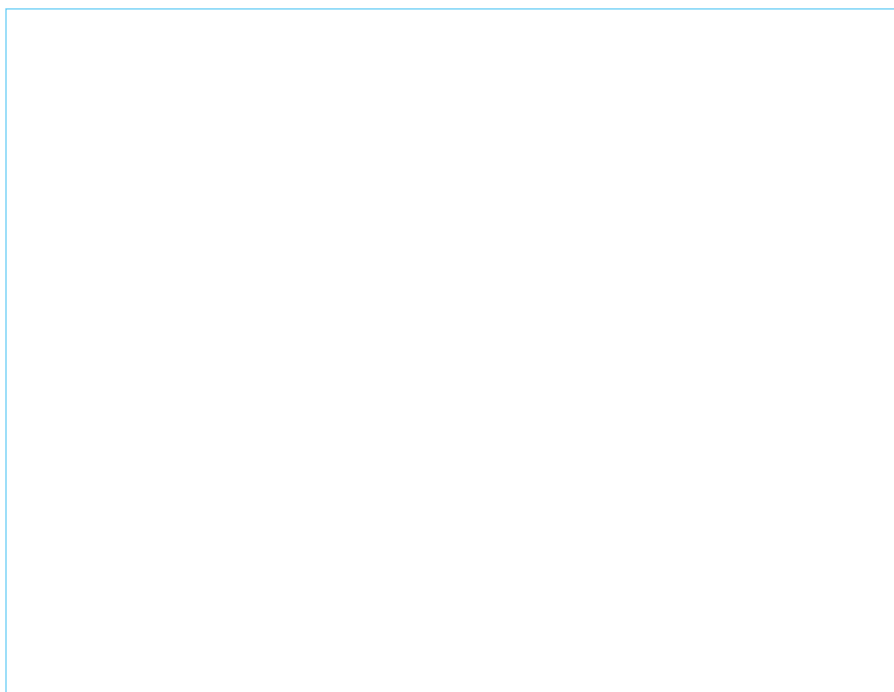
- In Celsius,  $0^{\circ}\text{C}$  is the freezing point of water and  $100^{\circ}\text{C}$  is the boiling point of water.
- In Fahrenheit,  $32^{\circ}\text{F}$  is the freezing point of water and  $212^{\circ}\text{F}$  is the boiling point of water.
- On the Kelvin scale,  $0\text{ K}$  is absolute zero.
- Temp in kelvins equals temp in  $^{\circ}\text{C}$  plus 273.
- Temp in  $^{\circ}\text{C}$  equals temp in kelvins minus 273.

**Identify** two pairs of objects that have about the same volume but different masses.

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---

**Model** three thermometers: one with a Fahrenheit scale, one with a Kelvin scale, and one with a Celsius scale. Label each to include the boiling and freezing points of water.



**Compare** the advantages and disadvantages of converting our system of measurement in the United States from the US customary system to the International System of units.

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## 2 Standards of Measurement (continued)

### CHECK YOUR PROGRESS

7. **Explain** why it is important to have exact standards of measurement.

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8. **Make a Table** Organize the following measurements from smallest to largest and include the multiplying factor for each: kilometer, nanometer, centimeter, meter, and micrometer.

Measurement	Multiplying factor

9. **Explain** why density is a derived unit.

---

---

10. **Math Connection** Make the following conversions: 27°C to kelvins, 20 dg to milligrams, and 3 m to decimeters.

27°C = \_\_\_\_\_

20 dg = \_\_\_\_\_

3 m = \_\_\_\_\_

11. **Math Connection** What is the density of an unknown metal that has a mass of 158 g and a volume of 20 mL? Use **Table 4** from your textbook to identify this metal.

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# The Nature of Science

## 3 Communicating with Graphs

### REVIEW VOCABULARY

data

Recall the definition of the Review Vocabulary term.

data

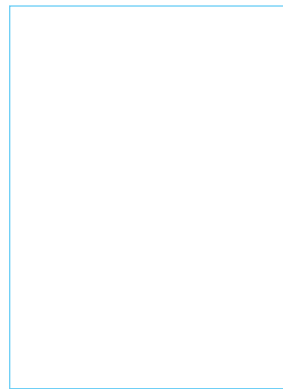
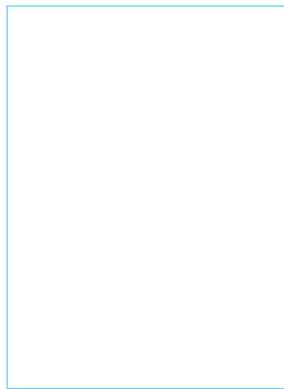
### NEW VOCABULARY

graph

Use your book to define the New Vocabulary term.

graph

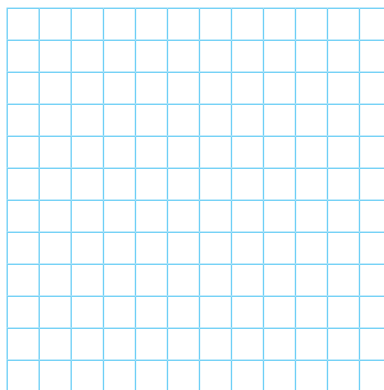
**Draw and label** a simple example of each of the three types of graphs described in this lesson.



### Line Graphs

- Show how 2 variables are related or how a variable changes over time.
- Vertical axis = dependent variable
- Horizontal axis = independent variable

**Evaluate** the effectiveness of two fertilizers on plant growth by plotting the following data on a line graph. Be sure to label each axis.



Week	Type A	Type B
1	2 cm	2 cm
2	7 cm	9 cm
3	15 cm	19 cm
4	20 cm	24 cm

### 3 Communicating with Graphs (continued)

#### Bar Graphs

- Used for data that doesn't change continuously, e.g. data collected by counting.

**Get It? Describe** possible data where using a bar graph would be better than using a line graph.

**Identify** the features of the bar graph in **Figure 16** in your textbook by completing the table below.

Feature	Description	Feature	Description
Label of x-axis		Maximum bar height	
Label of y-axis		Minimum bar height	
Horizontal scale		Maximum class size	
Vertical scale		Minimum class size	

#### Circle Graphs

- Also called pie charts
- Show how a whole is divided into parts
- Data is often in percentages that add up to 100%

**Analyze** the circle graph in **Figure 17** in your textbook to complete the second column in the table below. Then use the formula provided in the table to complete the third column. Remember to use the decimal form of the percent of whole in the formula when finding angle of slice. The first one has been done for you.

Heating Fuel	Percent of Whole	Angle of Slice [percent of whole $\times$ $360^\circ$ = angle of slice]
Gas	50	$0.50 \times 360^\circ = 180^\circ$
Steam		
Coal		
Electric		
Other		

### 3 Communicating with Graphs (continued)

**Complete** the paragraph below.

A \_\_\_\_\_ graph is used to show how a certain quantity is \_\_\_\_\_ into parts. The circle represents the \_\_\_\_\_ and the segments represent the \_\_\_\_\_ of the whole. The segments are usually given as \_\_\_\_\_ of the whole.

#### CHECK YOUR PROGRESS

**12. Identify** the kind of graph that would best show the results of a survey of 144 people where 75 ride a bus, 45 drive cars, 15 carpool, and 9 walk to work.

\_\_\_\_\_

**13. State** which type of variable is plotted on the x-axis and which type is plotted on the y-axis.

\_\_\_\_\_

\_\_\_\_\_

**14. Compare and Contrast** How are line, bar, and circle graphs similar? How are they different?

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

**15. Explain** why the points in a line graph can be connected.

\_\_\_\_\_

\_\_\_\_\_

**16. Math Connection** In a survey, it was reported that 56 out of 245 people would rather drink orange juice than coffee in the morning. Calculate what percentage of a circle graph orange-juice drinkers would occupy.

\_\_\_\_\_



# The Nature of Science

## 4 Science and Technology

### REVIEW VOCABULARY

industrialized

### VOCABULARY

technology

society

### What is technology?

- The application of scientific knowledge to help people or society

### 4 types of technology

- Objects
- Methods or techniques
- Knowledge or skills
- Systems

Recall the definition of the Review Vocabulary term.

industrialized

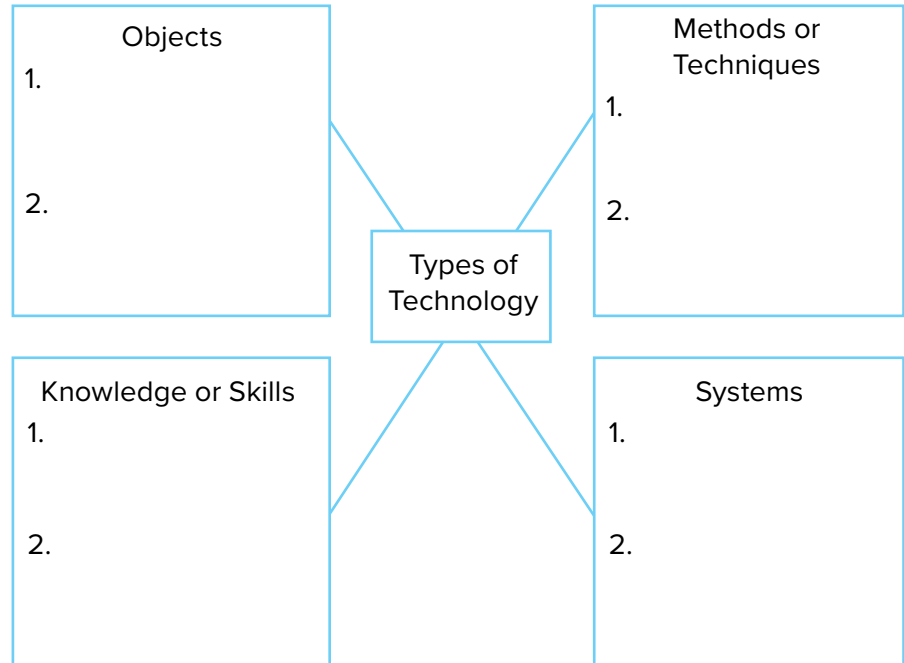
Use your book to define each term.

technology

society

Compare and contrast science and technology.

Organize information about types of technology by completing the concept web. Provide two examples of each type of technology.



## 4 Science and Technology (continued)

**Get It? Identify** another example of a technological system. Explain why it fits into this category.

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**Create** your own real-world example of how the application of a scientific discovery has helped create a new technology.

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**Get It? Compare and contrast** the technological needs of developing countries and industrialized countries.

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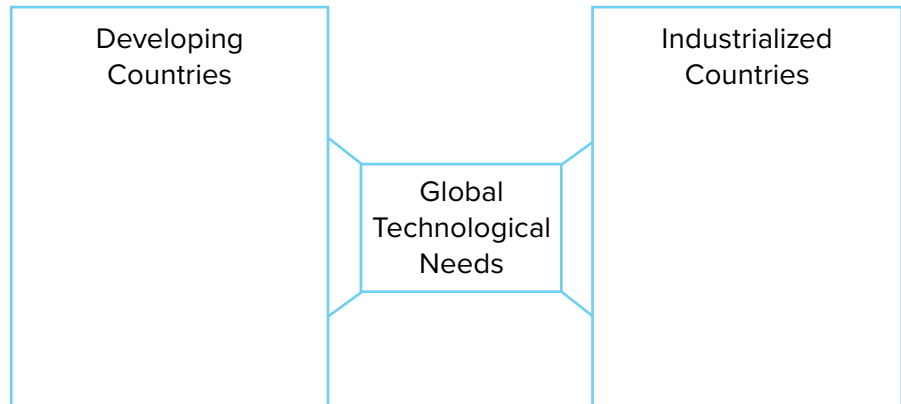
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## 4 Science and Technology (continued)

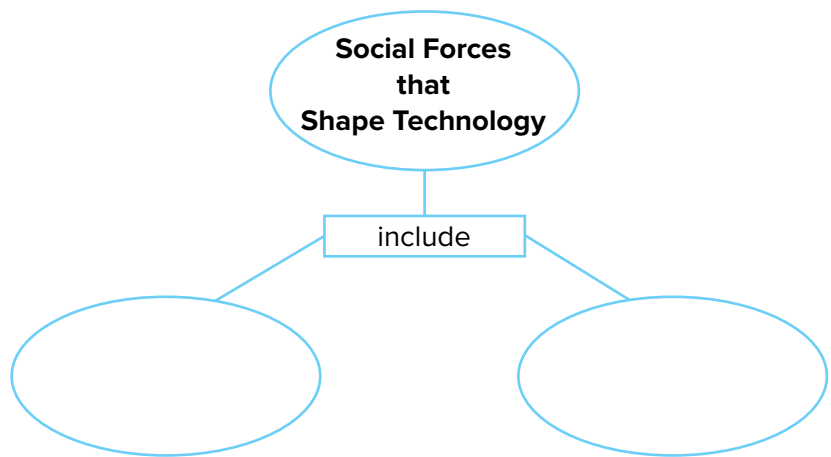
**Summarize** the focus of technological solutions in developing countries and industrialized countries.



### Social Forces that Shape Technology

- The values of individuals and society influence the development of technology.
- People support technologies by buying things, by donating to organizations that support research, and by voting.

**Complete** the concept web to identify the social forces that shape technology.



**Summarize** how social forces shape technology.

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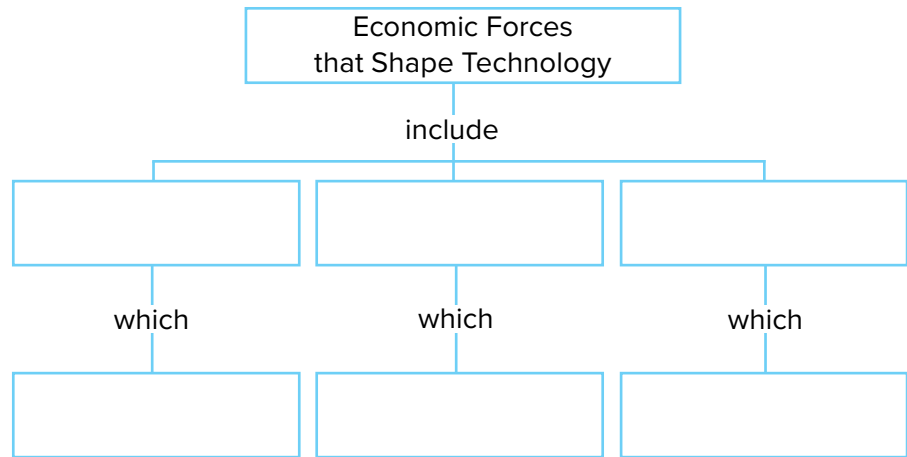
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## 4 Science and Technology (continued)

### Economic Forces that Shape Technology

- Many factors influence how money is spent on developing technology.
- The federal government, private foundations, and private industries all support research and development.

**Organize** information about economic forces that shape technology by completing the concept web.



**Summarize** the types of issues involved in developing technology responsibly by completing the table.

Type of Issue	Description of Issue	Example
Environmental	how technology affects plants, animals, and ecosystems	
Moral	what is right and wrong	
Ethical		Testing should not be done on people against their will.

## 4 Science and Technology (continued)

### CHECK YOUR PROGRESS

**17. Classify** the types of technology, and give at least two examples of each type.

---

---

**18. Explain** why the types of technology valued can vary.

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**19. Describe** how private citizens have a voice in which projects the federal government will fund.

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**20. Evaluate** Would cell phone technology be of use in a developing country? Explain your answer.

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**21. Math Connection** In 2010, the Department of Defense's overall budget was approximately \$534 billion. In the same year, the Department of Defense budgeted \$79.1 billion for research, development, tests, and evaluations. What percentage of the budget does this represent?

---



# 2 Motion

## ENCOUNTER THE PHENOMENON

Write the Encounter the Phenomenon question for this module.

Use the “What I Know” column to list the things you know about the Encounter the Phenomenon question. Then list the questions you have about the Encounter the Phenomenon question in the “What I Want to Find Out” column. As you read the module, fill in the “What I Learned” column.

<div>K</div> <div>What I Know</div>	<div>W</div> <div>What I Want to Find Out</div>	<div>L</div> <div>What I Learned</div>

# Motion

## 1 Describing Motion

### REVIEW VOCABULARY

meter

Recall the definition of the Review Vocabulary term.

*meter*

### NEW VOCABULARY

motion

displacement

speed

Use your book to define each term.

*motion*

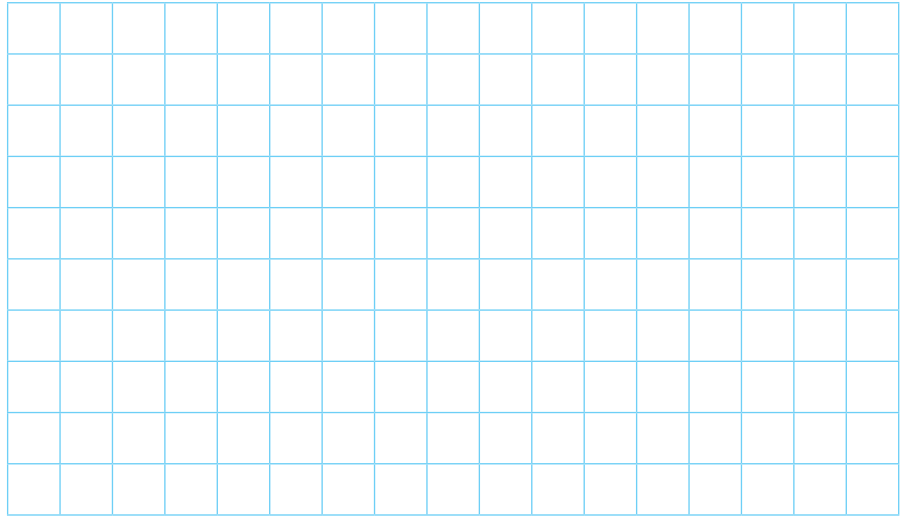
*displacement*

*speed*



## 1 Describing Motion (continued)

**Draw** a winding path that covers a distance of 70 miles and finishes with a displacement 20 miles southwest of the starting point. Label your diagram with the distance and direction traveled.



### Adding Displacements

**Summarize** the rules for adding displacements.

1. You can \_\_\_\_\_ displacements that are in the same direction.
2. You can \_\_\_\_\_ displacements that are in opposite directions.
3. You cannot directly add together displacements that are not in the \_\_\_\_\_ direction or in \_\_\_\_\_ directions.

**Get It? Determine** the total displacement of a dog that runs 15 m north, 6 m south, then 8 m north.

---

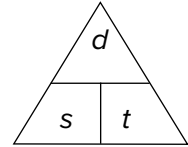
## 1 Describing Motion (continued)

### Speed Equation

**Analyze** the formula for speed by looking at the diagram and filling in the prompts.

Put your finger over the  $s$  on the diagram. Now write

the formula for speed. \_\_\_\_\_



Put your finger over the  $d$  on the diagram. Write the formula to find distance when you know speed and time. \_\_\_\_\_

Prove to yourself that these formulas are correct by checking the units.

$$\text{speed (units of } \quad \text{or } \quad ) = \frac{\text{distance (units of } \quad \text{or } \quad )}{\text{time (units of } \quad \text{or } \quad )}$$

Note that the units always turn out the same on both sides of the equation.

**Get It? Identify** two common ways of expressing a changing speed.

\_\_\_\_\_

**Get It? Identify** how to calculate average speed.

\_\_\_\_\_

**Get It? Identify** two examples of motion in which an object's instantaneous speed changes.

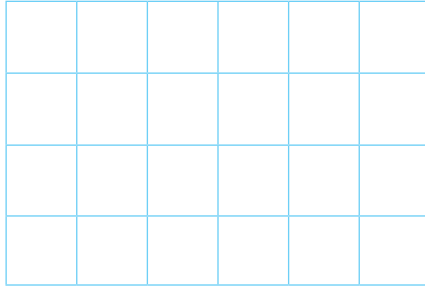
\_\_\_\_\_

\_\_\_\_\_

## 1 Describing Motion (continued)

### Distance-Time Graph

**Create** a graph to show the progress of a runner who runs a 1-kilometer race in 3 minutes. The runner gets off to a fast start, runs the middle of the race at a more moderate pace, and then sprints to the finish.



#### Graphing Checklist:

- title
- scale on x-axis
- units on x-axis
- label on x-axis
- scale on y-axis
- units on y-axis
- label on y-axis

## 1 Describing Motion (continued)

### CHECK YOUR PROGRESS

5. **Describe** the trip from your home to school using the words *position*, *distance*, *displacement*, and *speed*.
- 
- 
- 
6. **Explain** whether an object's displacement could be greater than the distance the object travels.
- 
- 
7. **Describe** the motion represented by a horizontal line on a distance-time graph.
- 
8. **Describe** the difference between average speed and constant speed.
- 
- 
9. **Explain** During a trip, can a car's instantaneous speed ever be greater than its average speed? Explain.
- 
- 
10. **Math Connection** Michiko walked a distance of 1.60 km in 30 min. Find her average speed in m/s.
- 
- 
11. **Math Connection** A car travels at a constant speed of 30.0 m/s for 0.80 h. Find the total distance traveled in km.
- 
-

# Motion

## 2 Velocity and Momentum

### REVIEW VOCABULARY

speed

Recall the definition of the Review Vocabulary term.

*speed*

### NEW VOCABULARY

velocity

momentum

Use your book to define each term.

*velocity*

*momentum*

## 2 Velocity and Momentum (continued)

**Get It?** **Describe** how velocity and speed are different.

**Describe** how two objects can have the same speed but different velocities.

**Summarize** changes that occur as a result of the slow motion of Earth's crust.

Moving plates can cause the formation of \_\_\_\_\_ ranges, earthquakes, and \_\_\_\_\_ eruptions. As a result of the slow movement of tectonic plates, the \_\_\_\_\_ Ocean is getting smaller, and the \_\_\_\_\_ Ocean is getting larger.

### Relative Motion

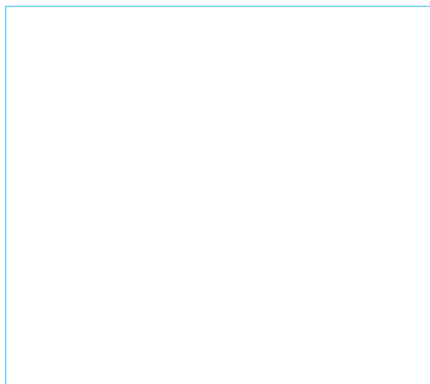
**Calculate** You are walking toward the back of a train that is moving forward with a constant velocity. The train's velocity relative to the ground is 30 m/s forward. Your velocity relative to the train is 1.5 m/s backward. What is your velocity relative to the ground?

## 2 Velocity and Momentum (continued)

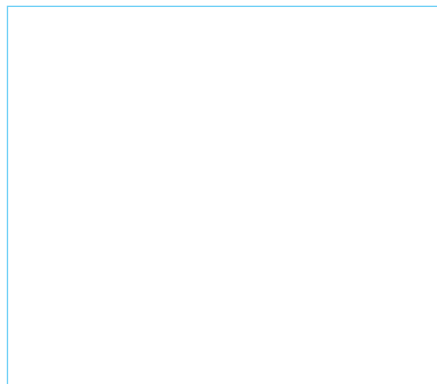
### Momentum

**Analyze** the property of momentum in words and with an equation. Include units and identify all variables.

Words



Equation



**Get It?** **Explain** whether momentum is a vector.

---

**Predict** why momentum is a property of moving objects, but not of stationary objects.

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---

## 2 Velocity and Momentum (continued)

### CHECK YOUR PROGRESS

**16. Describe** a car's velocity as it goes around a track at a constant speed.

---

**17. Explain** why streets and highways have speed limits rather than velocity limits.

---

---

**18. Identify** For each of the following news stories, determine whether the object's speed or velocity is given: the world record for the hundred-meter dash is about 10 m/s; the wind is 30 km/h from the northwest; a 200,000 kg train was traveling north at 70 km/h when it derailed; a car was issued a ticket for traveling at 140 km/h on the interstate.

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**19. Describe** You are walking toward the back of a bus that is moving forward with a constant velocity. Describe your motion relative to the frame of reference of the bus and relative to the frame of reference of a point on the ground.

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**20. Math Connection** What is the momentum of a 100-kg football player running north at a speed of 4 m/s?

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**21. Math Connection** Compare the momenta of a 6,300-kg elephant walking 0.11 m/s and a 50-kg dolphin swimming 10.4 m/s.

---

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# Motion

## 3 Acceleration

### REVIEW VOCABULARY

velocity

Recall the definition of the Review Vocabulary term.

*velocity*

### NEW VOCABULARY

acceleration

centripetal acceleration

Use your book to define each term.

*acceleration*

*centripetal acceleration*

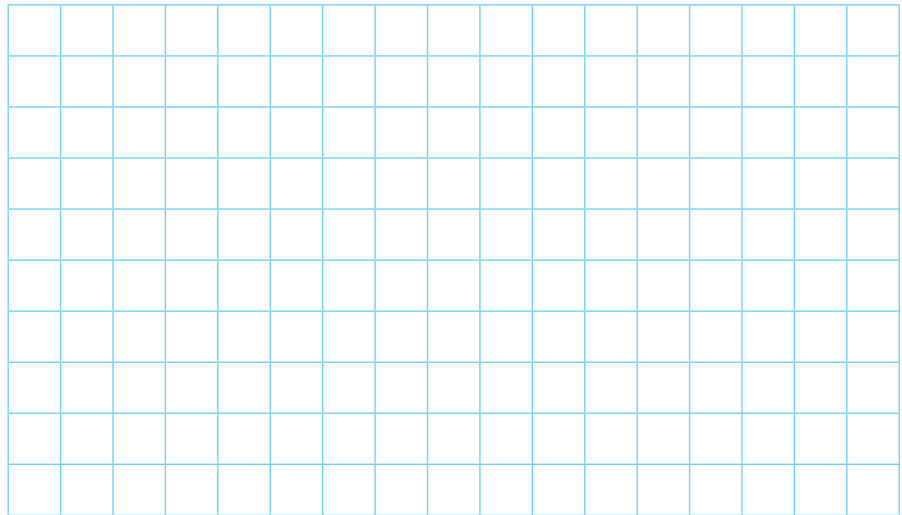
### 3 Acceleration (continued)

#### Speed-Time Graphs

**Get It?** **Identify** three ways that an object can accelerate.

**Synthesize** Create a graph titled “Speed Changing Over Time” to show the acceleration of a car.

- Include a label with units for each axis.
- Draw a line on the graph to show how the speed of the car changes with time.
- Include parts of your graph that represent the car speeding up, slowing down, and moving at a constant speed. Label each part.



**Compare** the results of applying the acceleration equation in the following two cases: (1) an object that goes from 0 to 10 m/s in 4 s, and (2) then goes from 10 m/s to 30 m/s in 8 s.

$$(1) a = (v_f - v_i)/t$$

$$= \underline{\hspace{2cm}} = \underline{\hspace{2cm}}$$

$$(2) a = (v_f - v_i)/t$$

$$= \underline{\hspace{2cm}} = \underline{\hspace{2cm}}$$

### 3 Acceleration (continued)

**Analyze** why the SI unit of acceleration is  $\text{m/s}^2$ .

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**Get It? Explain** why you cannot use the acceleration equation for an object that changes direction.

---

---

**Create** a top view of an object moving in a circle at constant speed, such as a ball on a string. Show at least two positions of the object. At each position, draw an arrow for the object's velocity and another arrow for the centripetal acceleration of the object.

### 3 Acceleration (continued)

**Get It?** Define the term *centripetal acceleration*.

---

---

#### Projectile Motion

**Model** a ball thrown horizontally. Sketch the path of the ball and draw arrows showing its horizontal and vertical velocity at three points along the path. Vary the length of your arrows to show the magnitude of the velocities.

### 3 Acceleration (continued)

#### CHECK YOUR PROGRESS

- 25. Describe** the acceleration of your bicycle as you ride it from your home to the store.

---

---

- 26. Determine** the change in velocity of a car that starts at rest and has a final velocity of 20 m/s north.

---

- 27. Analyze** the motion of an object that has an acceleration of  $0 \text{ m/s}^2$ .

---

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- 28. Compare** Suppose a car is accelerating so that its speed is increasing. First, describe the line that you would plot on a speed-time graph for the motion of the car. Then describe the line that you would plot on a distance-time graph.

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- 29. Math Connection** A ball is dropped from a cliff and has an acceleration of  $9.8 \text{ m/s}^2$ . How long will it take the ball to reach a speed of 24.5 m/s?

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- 30. Math Connection** A sprinter leaves the starting blocks with an acceleration of  $4.5 \text{ m/s}^2$ . What is the sprinter's speed 2 s later?

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# 3 Forces and Newton's Laws

## ENCOUNTER THE PHENOMENON

Write the Encounter the Phenomenon question for this module.

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Use the “What I Know” column to list the things you know about the Encounter the Phenomenon question. Then list the questions you have about the Encounter the Phenomenon question in the “What I Want to Find Out” column. As you read the module, fill in the “What I Learned” column.

K <i>What I Know</i>	W <i>What I Want to Find Out</i>	L <i>What I Learned</i>

# Forces and Newton's Laws

## 1 Forces

### REVIEW VOCABULARY

mass

Recall the definition of the Review Vocabulary term.

*mass*

### NEW VOCABULARY

force

net force

friction

gravity

field

weight

Use your book to define each term.

*force*

*net force*

*friction*

*gravity*

*field*

*weight*



## 1 Forces (continued)

**Model** an apple hanging from a tree and a falling apple. Include arrows with labels to show all forces acting on the apples.

Hanging Apple

Falling Apple

**Analyze** the forces acting on the apple in each drawing and how they combine to form the net force.

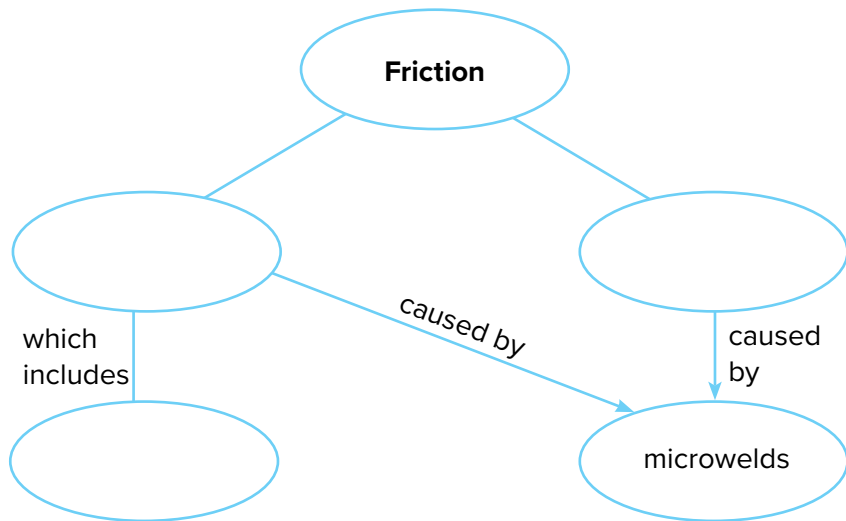
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**Complete** the concept map, using the information in your book.



**Get It?** Describe the source of friction.

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## 1 Forces (continued)

**Fill** in the blanks to complete the concept of friction.

The amount of friction between two \_\_\_\_\_ depends on the \_\_\_\_\_ of surfaces and the \_\_\_\_\_ pressing the surfaces together. Rougher surfaces have more bumps and can form \_\_\_\_\_, increasing the amount of friction.

**Summarize** the law of universal gravitation in a complete sentence.

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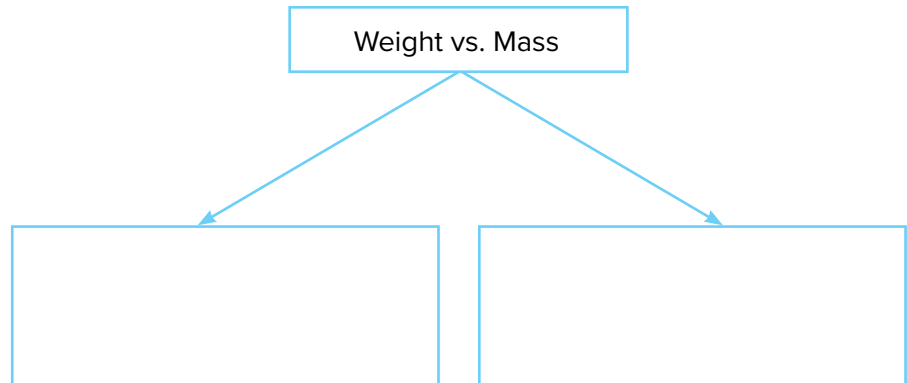
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**Write** the definitions of weight and mass in the boxes.



## 1 Forces (continued)

**Analyze** the formula  $F_g = mg$  to explain how an object's weight can change even when its mass remains constant.

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**Find** your weight on other planets by multiplying the gravitational field strength and your mass ( $F_g = mg$ ).

Planetary body	Your mass ( $m$ ) in kg	Gravitational field strength ( $g$ ) in N/kg	Your weight ( $F_g$ ) in N
Sun		275	
Mercury		3.70	
Venus		8.87	
Earth		9.81	
Mars		3.71	
Jupiter		24.8	
Saturn		10.4	
Uranus		8.69	
Neptune		11.2	

**Get It?** **Explain** why gravity is called a long-range force.

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## 1 Forces (continued)

### CHECK YOUR PROGRESS

4. **Describe** two forces that would change the motion of a bicycle traveling along a road.
- 
- 
5. **Explain** Can there be forces acting on an object if the object is at rest? Must there be an unbalanced force acting on a moving object? Explain your answers.
- 
- 
6. **Explain** Why does coating surfaces with oil reduce friction between the surfaces?
- 
- 
7. **Distinguish** between the mass of an object and the object's weight.
- 
- 
8. **Predict** Suppose Earth's mass increased but Earth's diameter did not change. Describe how the gravitational force between Earth and an object on its surface would change.
- 
- 
9. **Math Connection** On Earth, what is the weight of a large-screen TV that has a mass of 75 kg?
- 
- 
10. **Math Connection** Two students push on a box in the same direction, and one student pushes in the opposite direction. What is the net force on the box if each student pushes with a force of 50 N?
-

# Forces and Newton's Laws

## 2 Newton's Laws of Motion

### REVIEW VOCABULARY

acceleration

Recall the definition of the Review Vocabulary term.

*acceleration*

### NEW VOCABULARY

Newton's first law of  
motion

Use your book to define each term.

*Newton's first law of motion*

inertia

Newton's second law of  
motion

*inertia*

Newton's third law of  
motion

*Newton's second law of motion*

*Newton's third law of motion*

## 2 Newton's Laws of Motion (continued)

**Summarize** Newton's first law of motion by telling how an object in motion's inertia is changed and how an object at rest is affected.

An object in motion

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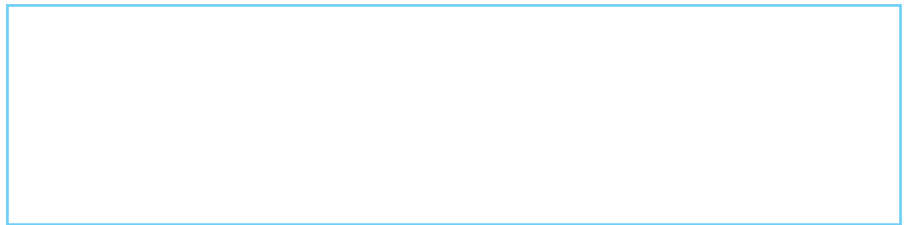
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An object at rest

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**Model** a rock being thrown at a wall and a car crashing into the wall.



**Predict** which object will do more damage, and support your answer by using the concept of inertia.

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**Analyze** the forces on a hockey puck sinking through water. Draw a force diagram for the puck in the water.

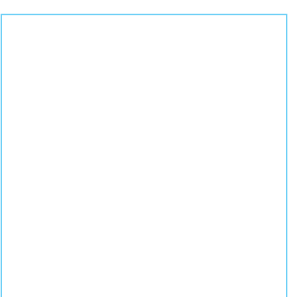
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## 2 Newton's Laws of Motion (continued)

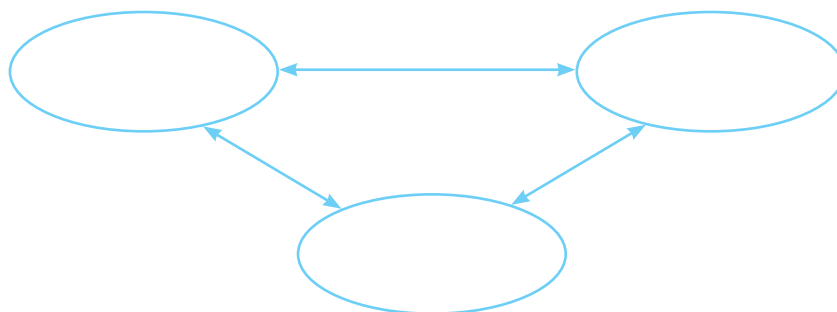
**Summarize** Newton's second law of motion in your own words.

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**Complete** the concept map with the 3 physical properties of an object that are related by Newton's second law of motion.



**Get It? Identify** You apply a force of 2 N to a toy car and to a real car. Which car has the greater acceleration?

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---

**Organize** the 3 variables related by Newton's second law in the table. Show equations to find each variable if you know the values of the other two variables.

Newton's Second Law of Motion		
Unknown Variable	Known Variables	Equations
Acceleration		
Net force		
Mass		

## 2 Newton's Laws of Motion (continued)

**Summarize** Newton's third law of motion in your own words.

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**Predict** the corresponding reaction for each action.

Action	Reaction
A high-jumper lands on a mat.	
A fisherman tosses an anchor away from his boat.	
An airplane's jet engine pushes air toward the back of the airplane.	

**Get It?** **Explain** why action and reaction forces do not cancel.

---

### CHECK YOUR PROGRESS

**15. Interpret and Apply** Use Newton's laws of motion to describe what happens when you kick a soccer ball.

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**16. Explain** why Newton's first law of motion is sometimes called the law of inertia.

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## 2 Newton's Laws of Motion (continued)

### CHECK YOUR PROGRESS

**17. Determine** whether the inertia of an object changes as the object's velocity changes.

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**18. Explain** why an object with a smaller mass has a larger acceleration than an object with a larger mass if the same force acts on each.

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**19. Identify** You push a book across a table. The book moves at a constant speed, but you do not move. Identify all of the forces on you. Then, identify all of the forces on the book.

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**20. Math Connection** A student pushes on a 5-kg box with a force of 20 N forward. The force of sliding friction is 10 N backward. What is the acceleration of the box?

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**21. Math Connection** You push yourself on a skateboard with a force of 30 N east and accelerate at  $0.5 \text{ m/s}^2$  east. Find the mass of the skateboard if your mass is 58 kg.

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# Forces and Newton's Laws

## 3 Using Newton's Laws

### REVIEW VOCABULARY

momentum

Recall the definition of the Review Vocabulary term.

momentum

### NEW VOCABULARY

air resistance

terminal velocity

free fall

centripetal force

law of conservation of  
momentum

Use your book to define each term.

air resistance

terminal velocity

free fall

centripetal force

law of conservation of momentum

### 3 Using Newton's Laws (continued)

**Analyze** the effects on a passenger riding in a car traveling at 50 km/h that collides head-on with a solid object.

Without Restraints	With Safety Belts and Air Bags

**Contrast** the terminal velocity of a parachutist with an open chute to the terminal velocity of the same parachutist with a closed chute.

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**Get It?** **Explain** why some objects fall faster than others.

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**Distinguish** between an object that is truly weightless and an object that is weightless because it is in free fall.

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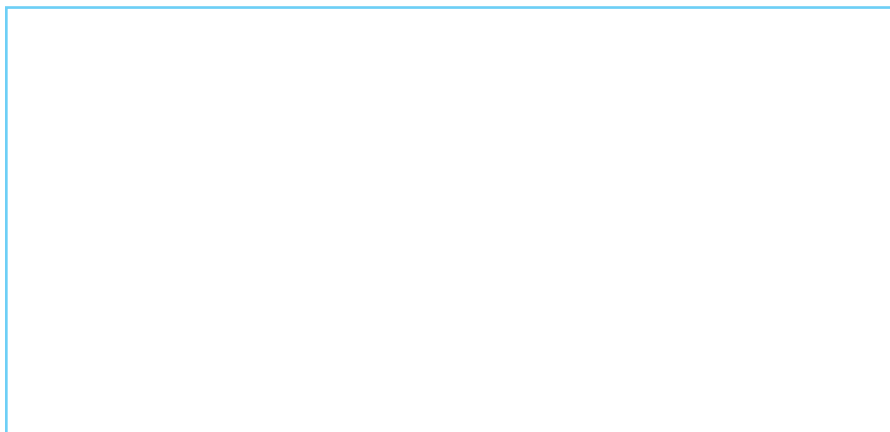
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### 3 Using Newton's Laws (continued)

**Create** a top view of an object moving in a circle at constant speed, such as a ball on a string. Show at least two positions of the object. At each position, draw an arrow for the object's velocity and another arrow for the centripetal acceleration of the object.



**Calculate** the force that is needed to propel a rocket into space if the rocket has a mass of 12,000 kg and it takes the rocket 10 min to reach 11 km/s, the escape velocity for Earth's gravity. (Hint: use the formula  $F = ma$ ).

Fill in the information below as you make your calculations.

Mass in kg	
Initial velocity in m/s	
Final velocity in m/s	
Time in s	
Force in N	

### 3 Using Newton's Laws (continued)

#### CHECK YOUR PROGRESS

- 22. Describe** Use Newton's laws to describe how inertia, gravity, and air resistance affect sky divers as they fall, open their parachutes, and reach terminal velocity.

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- 23. Discuss** the advantages of wearing a safety belt when riding in a vehicle.

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- 24. Explain** why planets orbit the Sun instead of traveling off into space.

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- 25. Describe** what happens to the momentum of two billiard balls that collide.

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- 26. Explain** how a rocket can move through outer space where there is no matter for it to push on.

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### 3 Using Newton's Laws (continued)

#### CHECK YOUR PROGRESS (CONTINUED)

- 27. Predict** Suppose you are standing on a scale in an elevator that is accelerating upward. Will the scale read your weight as larger or smaller than the weight it reads when you are stationary? Explain.

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- 28. Math Connection** A fuel-filled rocket is at rest. It burns its fuel and expels hot gas. The gas has a momentum of  $1500 \text{ kg}\cdot\text{m/s}$  backward. What is the momentum of the rocket?

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# 4 Work and Energy

## ENCOUNTER THE PHENOMENON

Write the Encounter the Phenomenon question for this module.

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Use the “What I Know” column to list the things you know about the Encounter the Phenomenon question. Then list the questions you have about the Encounter the Phenomenon question in the “What I Want to Find Out” column. As you read the module, fill in the “What I Learned” column.

K <i>What I Know</i>	W <i>What I Want to Find Out</i>	L <i>What I Learned</i>

# Work and Energy

## 1 Work and Machines

### REVIEW VOCABULARY

force

Recall the definition of the Review Vocabulary term.

force

### NEW VOCABULARY

work

machine

simple machine

compound machine

efficiency

mechanical advantage

Use your book to define each term.

work

machine

simple machine

compound machine

efficiency

mechanical advantage



## 1 Work and Machines (continued)

**Create** three sketches showing the following situations involving work.

A force is doing work.

A force is not doing work because there is no motion.

A force is not doing work because the force does not point in the direction of the motion.

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**Get It? Describe** the work done on an object when the force on that object and the motion of that object are perpendicular.

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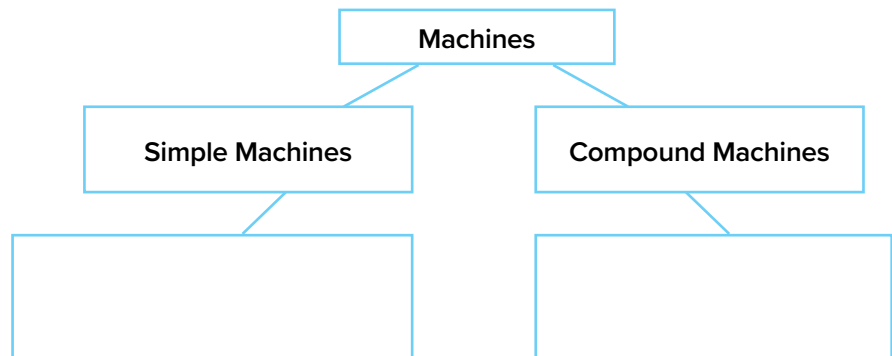
**Get It? Identify** at least two simple machines that can be found at a playground.

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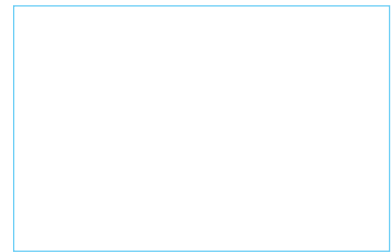
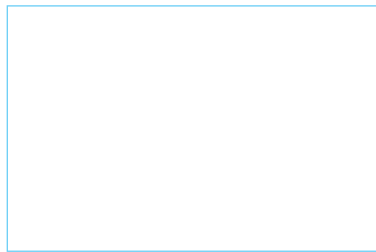
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## 1 Work and Machines (continued)

**Complete** the concept map relating simple and compound machines.



**Sketch** a nail and a screw. Explain which one uses less force and why.



**Get It? Compare** You use a ramp (an inclined plane) to help load a heavy crate into a truck. How does the work you put into this simple machine compare with the work you get out of the machine?

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---

## 1 Work and Machines (continued)

**Evaluate** the efficiency of two identical-looking lifts. Lift A can raise a 5-newton weight 4 meters in 3 seconds. Lift B can raise a 10-newton weight 3 meters in 3 seconds. The input work for each lift is 40 joules. (1 joule = 1 newton-meter.) Fill in the missing numbers below.

**What do you know?**

	Lift A	Lift B
Weight (newtons)		
Distance (meters)	4	
Time (seconds)	3	3
Input work ( $W_{in}$ )	40 J	40 J
Output work ( $W_{out}$ )		
Efficiency (%) = $W_{out} \div W_{in} \times 100$		

**Identify** how each machine changes the way work is done so as to be useful.

Bicycle

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Ax blade

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---

Car jack

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---

## 1 Work and Machines (continued)

### CHECK YOUR PROGRESS

- 10. Give an example** of a machine that increases speed, a machine that changes the direction of force, and a machine that increases force.

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- 11. Contrast** the scientific definition of *work* with its everyday meaning.

---

---

- 12. Compare** the output force with the input force for a machine that has a mechanical advantage that is greater than one.

---

- 13. Describe** how lubricating a machine affects the output work from that machine. How would the input and output forces be affected?

---

---

---

- 14. Math Connection** If you push a book 1.5 m across a table using a constant force of 10.0 N, how much work do you do on the book?

---

---

- 15. Math Connection** What is the efficiency of a ramp if the input work is 96 J and the output work is 24 J?

---

---

# Work and Energy

## 2 Describing Energy

### REVIEW VOCABULARY

work

Recall the definition of the Review Vocabulary term.

work

### NEW VOCABULARY

energy

system

kinetic energy

potential energy

elastic potential energy

chemical potential energy

gravitational potential  
energy

Use your book to define each term.

energy

system

kinetic energy

potential energy

elastic potential energy

chemical potential energy

gravitational potential energy

## 2 Describing Energy (continued)

**Get It? Identify** What limits the speed at which the ball will leave the racket?

---

**Get It? Identify** three different forms of energy.

---

---

---

**Create** an analogy to show how energy is like water.

---

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**Complete** the formula for the kinetic energy equation of a moving object. Use *mass (kg)*, *speed (m/s)*, and *kinetic energy (joules)* in your equation.

word equation:

$$\underline{\hspace{2cm}} = \frac{1}{2} \times \underline{\hspace{2cm}} \times \underline{\hspace{2cm}}^2$$

symbol equation:

## 2 Describing Energy (continued)

**Get It? Explain** how a book can have energy even if it is not moving.

---

---

**Identify** at least eight familiar items that involve energy. Group items by the form of energy they are associated with.

Kinetic	Potential

**Get It? Describe** how the elastic potential energy of a trampoline changes as a person jumps on it.

---

---

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---

---

**Analyze** the types of potential energy being used by an athlete competing in each of these athletic events.

archery

---

sprinting

---

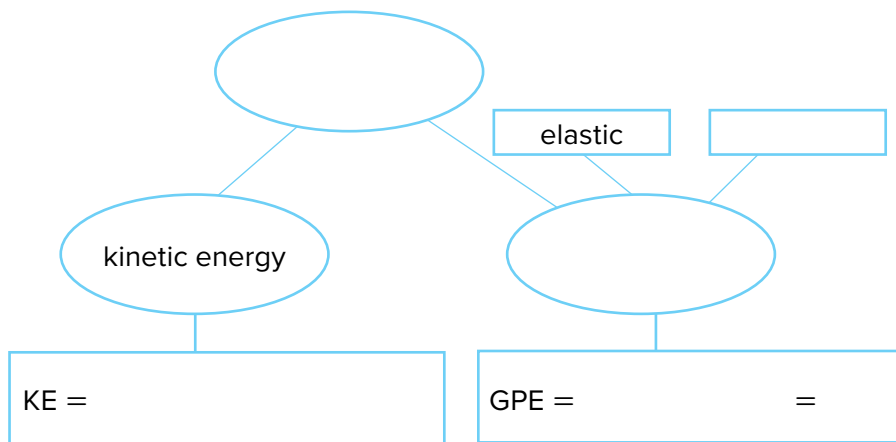
platform diving

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## 2 Describing Energy (continued)

**Complete** the concept map by entering each term or phrase in the appropriate location.

- chemical
- energy
- gravitational
- $mgh$
- potential energy
- $\frac{1}{2} \text{ mass} \times \text{velocity}^2$





## 2 Describing Energy (continued)

### CHECK YOUR PROGRESS

- 20. Describe** a change caused by kinetic energy as well as a change that involves potential energy.

---

---

---

- 21. Infer** whether a system can have kinetic energy and potential energy at the same time.

---

---

---

- 22. Differentiate** elastic potential energy and chemical potential energy.

---

---

---

- 23. Compare** The different molecules that make up the air in a room have, on average, the same kinetic energy. How does the speed of the different molecules that make up the air depend on their masses?

---

---

- 24. Math Connection** A 0.06-kg ball is moving at 5.0 m/s. How large is the kinetic energy from this motion?

---

- 25. Math Connection** A 0.50-kg apple is 2.0 m above the reference level. What is the GPE of the apple-Earth system?

---

# Work and Energy

## 3 Conservation of Energy

### REVIEW VOCABULARY

friction

Recall the definition of the Review Vocabulary term.

friction

### NEW VOCABULARY

law of conservation of  
energy

mechanical energy

power

Use your book to define each term.

law of conservation of energy

mechanical energy

power

### 3 Conservation of Energy (continued)

**Get It?** **State** the law of conservation of energy.

---

---

**Predict** the energy transformations when a fast-moving roller coaster finishes its ride and comes to a stop. Give three possibilities.

1. 

---

---
2. 

---

---
3. 

---

---

**Create** a drawing of an apple falling from a tree. Label where:

- kinetic energy is low and gravitational potential energy is high
- kinetic energy is high and gravitational potential energy is low
- kinetic energy is about equal to gravitational potential energy

**Get It?** **Describe** what happens to the mechanical energy of the apple-Earth system as the apple falls from the tree.

---

---

### 3 Conservation of Energy (continued)

**Get It? Explain** whether the ball has potential energy when it leaves the bat.

---

---

**Get It? Explain** why the ball is moving faster just before it hits the ground than when it left the bat but the mechanical energy of the ball-Earth system is still constant.

---

---

---

---

**Compare and contrast** the mechanical energy of a ball thrown as a projectile with the mechanical energy of a swing in motion.

Alike	Different

### 3 Conservation of Energy (continued)

**Get It?** **Infer** why the wheels of a car get hot when the car is driven.

---

---

---

**Analyze** Describe two ways to increase power.

1. 

---

---

2. 

---

---

### 3 Conservation of Energy (continued)

#### CHECK YOUR PROGRESS

- 28. Apply** the law of conservation of energy and describe the energy transformations that occur as you coast down a long hill on a bicycle and then apply the brakes to make the bike stop at the bottom.

---

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---

- 29. Identify** whether each of the following is a form of mechanical energy: elastic potential energy, chemical potential energy, gravitational potential energy.

---

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- 30. Explain** how friction affects the mechanical energy of a system.

---

- 31. Compare** A roller coaster is at the top of a hill and rolls to the top of a lower hill. If mechanical energy is constant, then on the top of which hill is the kinetic energy from the roller coaster's motion greater?

---

---

- 32. Math Connection** Approximately how much electrical energy does a 5-W lightbulb convert to radiant and thermal energy in one hour?

---

---

- 33. Math Connection** The mechanical energy of a bicycle at the top of a hill is 6,000 J. The bicycle stops at the bottom of the hill by applying the brakes. If the gravitational potential energy of the bicycle-Earth system is 2,000 J at the bottom of the hill, how much mechanical energy was converted into thermal energy?

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# 5 Thermal Energy

## ENCOUNTER THE PHENOMENON

Write the Encounter the Phenomenon question for this module.

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---

Use the “What I Know” column to list the things you know about the Encounter the Phenomenon question. Then list the questions you have about the Encounter the Phenomenon question in the “What I Want to Find Out” column. As you read the module, fill in the “What I Learned” column.

K <i>What I Know</i>	W <i>What I Want to Find Out</i>	L <i>What I Learned</i>

# Thermal Energy

## 1 Temperature, Thermal Energy, and Heat

### REVIEW VOCABULARY

kinetic energy

Recall the definition of the Review Vocabulary term.

kinetic energy

### NEW VOCABULARY

temperature

thermal energy

heat

specific heat

Use your book to define each term.

temperature

thermal energy

heat

specific heat



## 1 Temperature, Thermal Energy, and Heat (continued)

**Compare** the motion of the atoms or molecules that make up a hot object to the atoms or molecules that make up a cold object.

---

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**Analyze** how each of the three actions in the table increases the kinetic, potential, or total thermal energy of a substance.

Actions that increase thermal energy	Explanation
raise the temperature of the object	
pull atoms or molecules that attract one another farther apart	
add mass to the object, without changing its temperature	

**Get It?** **Explain** the difference between temperature and thermal energy.

---

---

---

**Model** the flow of heat from a hot object to a cold one. Show the heat flow and some particles in the hot and cold objects.

## 1 Temperature, Thermal Energy, and Heat (continued)

**Get It?** Define specific heat.

---

---

---

**Compare and contrast** what happens in a metal to what happens to a mass of water when each is heated.

---

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**Evaluate** the amount of thermal energy lost from a 0.5-kg glass casserole dish when it is placed in water. The dish's temperature changes from  $110^{\circ}\text{C}$  to  $50^{\circ}\text{C}$ .

Hints: 1. Start by writing the equation for the change in thermal energy of an object.

2. Find the specific heat for glass in the table in your book.

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## 1 Temperature, Thermal Energy, and Heat (continued)

**Sequence** steps to use a calorimeter to find the specific heat of a material. Include steps for measurement and steps for calculation.

1. \_\_\_\_\_  
\_\_\_\_\_
2. \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_
3. \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_
4. \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

**Describe** three or four processes in nature or daily life that depend on the high specific heat of water.

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---

## 1 Temperature, Thermal Energy, and Heat (continued)

### CHECK YOUR PROGRESS

4. **Describe** how the motions of the particles that make up an object change when the object's temperature increases.

---

---

5. **Describe** the energy transfer when you touch a block of ice with your hand.

---

---

6. **Infer** When one object heats another, does the temperature increase of one object always equal the temperature decrease of the other object? Explain.

---

7. **Explain** why water is often used as a coolant.

---

8. **Explain** whether the following statement is true: For any two objects, the one with the higher temperature always has more thermal energy.

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---

9. **Estimate** the change in the thermal energy of water in a pond with a mass of 1000 kg and a specific heat of  $4200 \text{ J}/(\text{kg}\cdot^{\circ}\text{C})$  if the water cools by  $1^{\circ}\text{C}$ .

---

10. **Calculate** the specific heat of a metal if 0.3 kg of the metal absorb 9000 J of heat as the metal warms by  $10^{\circ}\text{C}$ .

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# Thermal Energy

## 2 Conduction, Convection, and Radiation

### REVIEW VOCABULARY

density

Recall the definition of the Review Vocabulary term.

density

### NEW VOCABULARY

conduction

convection

radiation

thermal insulator

Use your book to define each term.

conduction

convection

radiation

thermal insulator

## 2 Conduction, Convection, and Radiation (continued)

**Compare** and contrast conduction, convection, and radiation by completing the table.

Description	Sketch	Sketch
Conduction:		
Convection:		
Radiation:		

## 2 Conduction, Convection, and Radiation (continued)

**Get It?** **Explain** how convection and density are related.

---

---

---

**Get It?** **Contrast** conduction with convection.

---

---

---

**Get It?** **Identify** two different animal adaptations for controlling the transfer of thermal energy.

---

---

**Organize** the energy-controlling features of some animals in the following table. Write the feature and describe its role in helping the animal control thermal energy.

Animal	Feature	Role
Antarctic fur seal		
Emperor penguin		
Desert spiny lizard	scaly skin	reflects Sun's rays

## 2 Conduction, Convection, and Radiation (continued)

**Get It? Explain** how trapped air makes a material, such as fleece, a good thermal insulator.

---

---

**Get It? Explain** why insulation is just as important in hot climates as it is in cold climates.

---

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---

**Analyze** how the vacuum between the inner and outer walls of a thermos bottle limits energy loss through conduction and convection.

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---

**List** the methods you use to control the flow of thermal energy to and from your body. Explain the purpose of each method.

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## 2 Conduction, Convection, and Radiation (continued)

### CHECK YOUR PROGRESS

- 11. Identify** which method of thermal energy transfer would be fastest through a vacuum, which would be fastest through a gas, and which would be fastest through a solid.

---

---

- 12. Explain** why the air temperature near the ceiling of a room tends to be warmer than the air temperature near the floor.

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- 13. Predict** whether plastic foam, which contains pockets of air, would be a good thermal conductor or a good thermal insulator.

---

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- 14. Infer** Several days after a snowfall, the roofs of some homes on a street have almost no snow on them, while the roofs of other homes are still snow-covered. Give one reason, related to home insulation, that might cause this difference.

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- 15. Calculate Solar Radiation** Averaged over a year in the central United States, radiation from the Sun transfers about 200 W to each square meter of Earth's surface. If a house is 10 m long by 10 m wide, how much solar energy falls on the house each second?

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# Thermal Energy

## 3 Using Thermal Energy

### REVIEW VOCABULARY

mechanical energy

Recall the definition of the Review Vocabulary term.

*mechanical energy*

### VOCABULARY

Write the correct vocabulary term in the left column for each definition below.

a heating system that absorbs radiant energy from the Sun

the study of the relationship among thermal energy, heat, and work

states that the increase in thermal energy of a system equals the work done on the system plus the thermal energy transferred to the system if the mechanical energy of the system is constant

states that it is impossible for thermal energy to transfer from a cool object to a warmer object unless work is done

a device that transforms thermal energy into mechanical energy

a heat engine that burns fuel in internal chambers

### 3 Using Thermal Energy (continued)

**Get It? Identify** the energy transformation that occurs in an electric heating system.

**Compare and contrast** radiator-based, electric, and forced-air heating systems for buildings.

System Type	Source of Thermal Energy	How Thermal Energy Is Transported	How Thermal Energy Spreads
radiator-based			
electric			
forced-air			

**Get It? Describe** the function of a solar collector.

**Sequence** how solar collectors work.

1. \_\_\_\_\_
2. \_\_\_\_\_
3. \_\_\_\_\_
4. \_\_\_\_\_

### 3 Using Thermal Energy (continued)

**Complete** the equation that expresses the first law of thermodynamics.

Increase in <hr style="width: 80%; margin: 5px auto;"/> of system	=	<hr style="width: 80%; margin: 5px auto;"/> on system	+	<hr style="width: 80%; margin: 5px auto;"/> to system
--	---	---	---	---

**Get It? Identify** two ways to increase the temperature of a system.

---

**Contrast** the characteristics of a non-isolated system and an isolated system.

---



---



---

**Sequence** the four strokes of a standard automobile in their functional order. Fill in the other columns to describe what happens during each stroke.

Name of Stroke	Which valves are open?	What are the gases doing?	Piston movement (up/down)	Power generated? (yes/no)

### 3 Using Thermal Energy (continued)

**Summarize** the steps a refrigerator takes to transfer heat by filling in the blanks with words from the word bank. Some words may be used more than once.

colder

gas

heat

liquid

warmer

work

Liquid coolant changes into a \_\_\_\_\_. In doing so, it becomes \_\_\_\_\_.

Cold gas absorbs \_\_\_\_\_ from refrigerator interior, and the gas becomes \_\_\_\_\_.

Gas releases \_\_\_\_\_ to the room, and the gas becomes \_\_\_\_\_. The gas turns into a \_\_\_\_\_.

The compressor does \_\_\_\_\_ compressing the gas, which becomes even \_\_\_\_\_.

**Explain** why electric generators do not convert mechanical energy into electrical energy with 100% efficiency.

---

---

**Analyze** A refrigerator is a device that causes heat to flow from a cool object (such as a pitcher of water) to a warm object (the air in the kitchen). Explain why this does not violate the second law of thermodynamics.

---

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---

### 3 Using Thermal Energy (continued)

#### CHECK YOUR PROGRESS

**16. Describe** a device that transforms thermal energy into another useful form.

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**17. Explain** how the thermal energy of an isolated system changes with time if the mechanical energy of that system is constant.

---

---

**18. Compare and contrast** an active solar heating system with a radiator system.

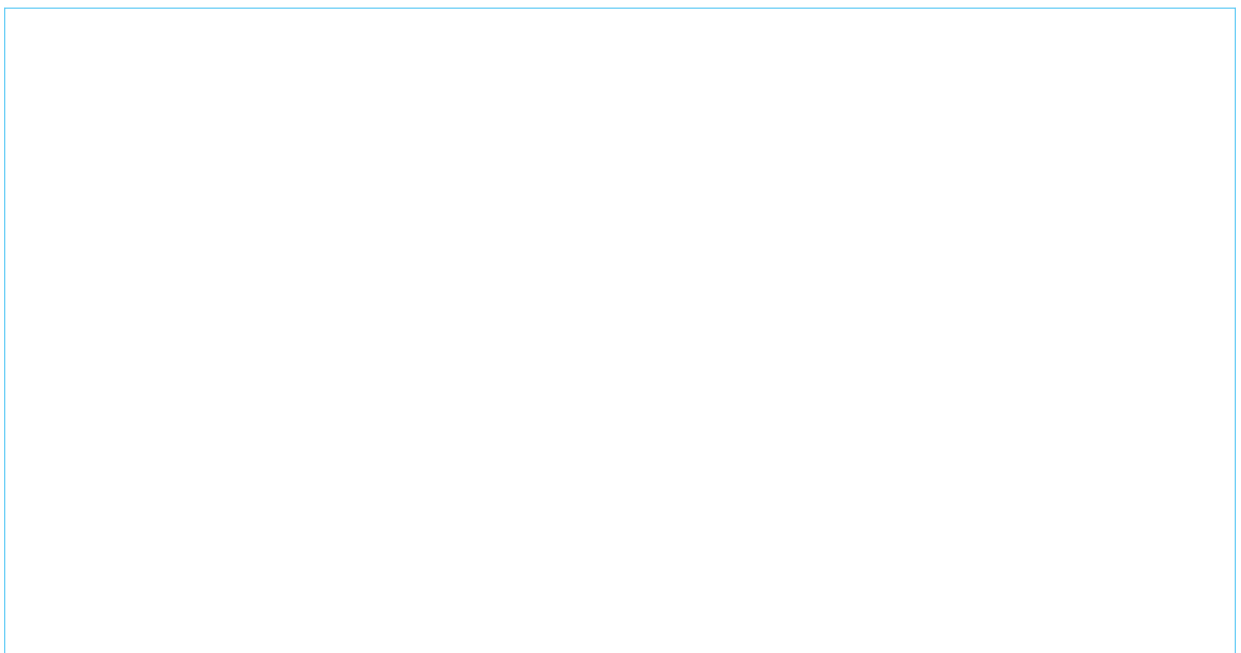
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---

**19. Predict** whether energy will ever spontaneously transfer from a cold pot of water to a hot stove.

---

**20. Diagram** how the thermal energy of the coolant changes as the coolant flows through the refrigerator.



### 3 Using Thermal Energy (continued)

#### CHECK YOUR PROGRESS (CONTINUED)

**21. Predict** Suppose you vigorously shake a bottle of fruit juice. Predict how the temperature of the juice will change. Explain your reasoning.

---

---

**22. Calculate Change in Thermal Energy** Suppose you push down on the handle of a bicycle pump with a force of 20 N. The handle moves 0.3 m, and there is no heat between the pump and its surroundings. What is the change in thermal energy of the bicycle pump?

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# 6 Electricity

## ENCOUNTER THE PHENOMENON

Write the Encounter the Phenomenon question for this module.

Use the “What I Know” column to list the things you know about the Encounter the Phenomenon question. Then list the questions you have about the Encounter the Phenomenon question in the “What I Want to Find Out” column. As you read the module, fill in the “What I Learned” column.

<div>K</div> <div>What I Know</div>	<div>W</div> <div>What I Want to Find Out</div>	<div>L</div> <div>What I Learned</div>

# Electricity

## 1 Electric Charge

### REVIEW VOCABULARY

gravity

Recall the definition of the Review Vocabulary term.

gravity

### NEW VOCABULARY

static electricity

law of conservation  
of charge

electric field

conductor

insulator

charging by contact

charging by induction

electroscope

Use your book to define each term.

static electricity

law of conservation of charge

electric field

conductor

insulator

charging by contact

charging by induction

electroscope

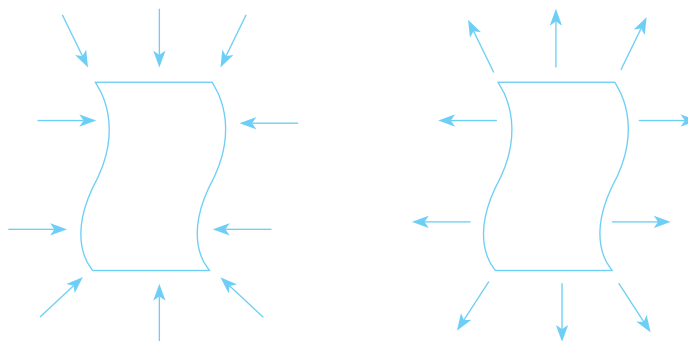
## 1 Electric Charge (continued)

**Get It? Compare** the number of electrons with the number of protons in a charged object.

---

---

**Model** charges and electric fields of two items that have just been removed from a clothes dryer.



**Get It? Explain** why the arrows point away from positive charges and toward negative charges in electric field diagrams.

---

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---

## 1 Electric Charge (continued)

**Complete** the following paragraph about the factors that affect electric forces.

Unlike gravitational forces, electric forces can be either attractive or \_\_\_\_\_. Opposite charges \_\_\_\_\_ each other, and like charges \_\_\_\_\_ each other. The strength of the electric force between two charges depends on the \_\_\_\_\_ of charge as well as the \_\_\_\_\_ between charges.

**Get It? Compare** the strength of electric forces between protons and electrons to the strength of gravitational forces between them.

---

---

---

**Compare** the strengths of electric forces and gravitational forces by completing the table.

Where	Which is stronger—electric force or gravitational force?
Between electrons and protons in an atom	
Between hydrogen and oxygen in water	
Between you and Earth	
Between Earth and the sun	

## 1 Electric Charge (continued)

**Get It? Contrast** conductors with insulators.

---

---

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**List** 5 conductors and 5 insulators in the spaces below.

**Conductors**

**Insulators**

<hr/>	<hr/>
<hr/>	<hr/>
<hr/>	<hr/>
<hr/>	<hr/>
<hr/>	<hr/>

**Get It? Contrast** charging by contact with charging by induction.

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---

**Get It? Describe** What is lightning?

---

---

## 1 Electric Charge (continued)

**Identify** the type of charging that occurs in each event as charging by contact or charging by induction. Then describe how the charges move.

You feel a tingling sensation during a thunderstorm.

---

---

A lightning rod moves excess charges to Earth's surface.

---

---

**Get It?** **Explain** the purpose of grounding.

---

---

**Get It?** **Identify** the purpose of an electroscope.

---

---

**Sequence** the events that occur when an electroscope is used to detect a charge on an object. Write numbers from 1 to 4 to the left of the events to show the correct sequence.

- \_\_\_\_\_ The leaves repel each other and spread apart.
- \_\_\_\_\_ A charged object touches the knob.
- \_\_\_\_\_ Both leaves become positively (or negatively) charged.
- \_\_\_\_\_ Electrons travel up (or down) the rod.

## 1 Electric Charge (continued)

### CHECK YOUR PROGRESS

1. **Predict** what would happen if you touched the knob of a positively charged electroscope with a negatively charged object. Explain your prediction.

---

---

---

2. **Compare and contrast** electric force with gravitational force.

---

---

3. **Differentiate** between conductors and insulators.

---

---

4. **Explain** how electrically neutral objects can become charged even though charge cannot be created or destroyed.

---

---

5. **Infer** Humid air is a better electrical conductor than dry air. Explain why you are more likely to receive a shock after walking across a carpet when the air is dry than when the air is humid.

---

---

6. **Math Connection** A 0.020-kg balloon is charged by rubbing and then stuck to the ceiling. If the strength of Earth's gravity on an object is 9.8 N/kg, how large is the electric force on the balloon?

---

# Electricity

## 2 Electric Current

### REVIEW VOCABULARY

SI

Recall the definition of the Review Vocabulary term.

SI

### NEW VOCABULARY

electric current

voltage difference

electric circuit

resistance

Ohm's law

Use your book to define each term.

*electric current*

*voltage difference*

*electric circuit*

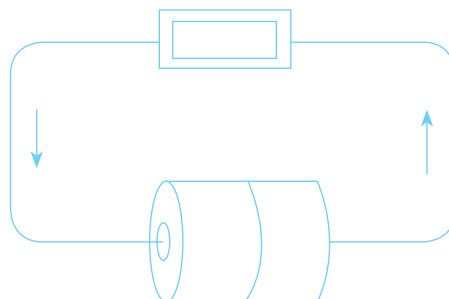
*resistance*

*Ohm's law*



## 2 Electric Current (continued)

**Create** a drawing of an electric circuit that has a battery powering a digital clock. Show the direction of electron flow, and describe the movement of the electrons in the circuit.



**Get It? Contrast** the direction of current with the direction of electron flow.

## 2 Electric Current (continued)

**Describe** the components of each type of battery. In your own words, explain how it works.

Battery Type	Components	How It Works
Dry-cell battery		
Wet-cell battery		

**Get It?** **Contrast** a dry-cell battery with a wet-cell battery.

---

---

## 2 Electric Current (continued)

**Express** the three equations that come from Ohm's law.

Unknown value	Known values	Equation
Current	Voltage difference Resistance	
Resistance		
Voltage difference		

**Contrast** direct current and alternating current.

---

---

---

## 2 Electric Current (continued)

### CHECK YOUR PROGRESS

**10. Compare and contrast** a current through a circuit with a static discharge.

---

---

**11. Compare and contrast** the cause of a flow of water in a pipe and the cause of a flow of electrons in a wire.

---

---

**12. Explain** how a carbon-zinc dry cell produces a voltage difference between the positive and negative terminals.

---

---

**13. Identify** two ways to increase the current in a simple circuit.

---

---

**14. Explain** how the resistance of the heating element in an electric heater changes as it gets hotter, transferring thermal energy to the heater's surroundings at a faster and faster rate.

---

---

**15. Math Connection** Calculate the voltage difference in a circuit that has a resistance of  $24\ \Omega$  if the current is  $0.50\ \text{A}$ .

---

# Electricity

## 3 More Complex Circuits

### REVIEW VOCABULARY

power

Recall the definition of the Review Vocabulary term.

*power*

### NEW VOCABULARY

series circuit

parallel circuit

electrical power

Use your book to define each term.

*series circuit*

*parallel circuit*

*electrical power*

### 3 More Complex Circuits (continued)

**Describe** the circuitry of three strings of patio lights plugged into the same extension cord. One whole string does not light, but all the bulbs in the other two strings do.

---

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---

**Get It? Explain** what happens when you open one branch of a parallel circuit.

---

---

**Get It? Identify** the purpose of fuses and circuit breakers in household circuits.

---

---

**Compare and contrast** fuses and circuit breakers.

Similarities	Differences

### 3 More Complex Circuits (continued)

**Identify** what kinds of circuits are most common in household wiring.

---

**Identify** three devices that convert electrical energy to another form of energy. Fill in the table below to show the energy conversions.

Device	Converts electrical energy to...

**Express** three equations that come from the definition of electrical power.

Unknown value	Known values	Equation
Electrical power	Current Voltage difference	
Current		
Voltage difference		

**Distinguish** between electrical power and electrical energy. Include units in your answer.

---

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---

### 3 More Complex Circuits (continued)

#### CHECK YOUR PROGRESS

**24. Compare** series circuits with parallel circuits.

---

---

**25. Explain** what determines the current in each branch of a parallel circuit.

---

---

**26. Infer** whether a circuit breaker should be connected in parallel to the circuit that it is protecting.

---

---

**27. Relate** A parallel circuit with four branches is connected to a battery. Explain how the amount of current from the battery is related to the amount of current in the branches of the circuit.

---

---

**28. Math Connection** Calculate the current into a desktop computer plugged into a 120-V outlet if the power used is 180 W.

---

---

**29. Math Connection** A circuit breaker trips when the current in the circuit reaches 15 A. If the voltage is 120 V, how much power is being used when the breaker is tripped?

---

---

**30. Math Connection** Estimate the monthly cost of using a 700-W refrigerator that runs for 10 h a day if the cost per kWh is \$0.20.

---

---



# 7 Magnetism and Its Uses

## ENCOUNTER THE PHENOMENON

Write the Encounter the Phenomenon question for this module.

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---

Use the “What I Know” column to list the things you know about the Encounter the Phenomenon question. Then list the questions you have about the Encounter the Phenomenon question in the “What I Want to Find Out” column. As you read the module, fill in the “What I Learned” column.

K <i>What I Know</i>	W <i>What I Want to Find Out</i>	L <i>What I Learned</i>

# Magnetism and Its Uses

## 1 Magnetism

### REVIEW VOCABULARY

electric field

Recall the definition of the Review Vocabulary term.

electric field

### NEW VOCABULARY

magnetism

magnetic field

magnetic pole

magnetic domain

Use your book to define each term.

magnetism

magnetic field

magnetic pole

magnetic domain

## 1 Magnetism (continued)

**Organize** important facts about magnets by completing the outline.

Magnets

### A. Magnetic force

1. \_\_\_\_\_
2. \_\_\_\_\_
3. \_\_\_\_\_

### B. Magnetic field

1. \_\_\_\_\_
2. \_\_\_\_\_
3. \_\_\_\_\_

### C. Magnetic poles

1. \_\_\_\_\_
2. \_\_\_\_\_
3. \_\_\_\_\_
4. \_\_\_\_\_
  - a. \_\_\_\_\_
  - b. \_\_\_\_\_

### D. Compass

1. \_\_\_\_\_
2. \_\_\_\_\_
3. \_\_\_\_\_

### E. Earth as a magnet

1. \_\_\_\_\_
2. \_\_\_\_\_
3. \_\_\_\_\_

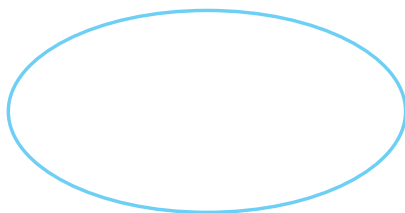
## 1 Magnetism (continued)

**Get It?** Explain why the atoms of magnetic materials behave like small magnets.

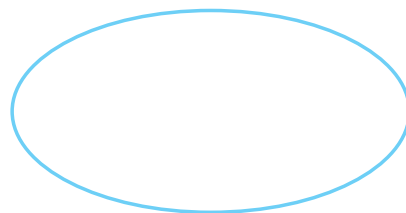
**Classify** each metal as magnetic or nonmagnetic.

aluminum	cobalt	copper	gold
iron	mercury	nickel	silver

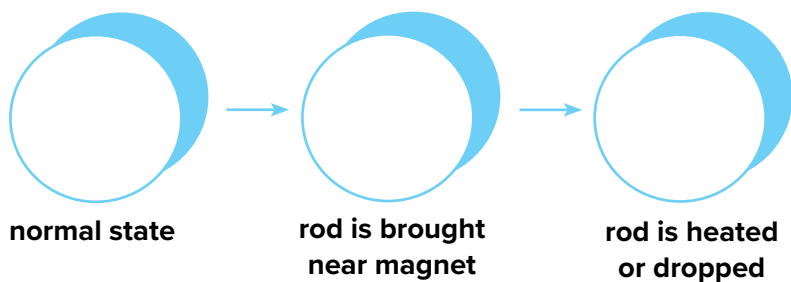
**Magnetic**



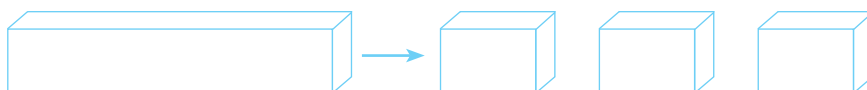
**Nonmagnetic**



**Model** a close-up of the magnetic domains of the cross sections of an iron rod in each of these situations.



**Identify** the poles of a magnet before and after it is sliced into three pieces.



## 1 Magnetism (continued)

### CHECK YOUR PROGRESS

1. **Explain** Why does a magnet exert a force on another magnet when the two magnets are not in contact?

---

---

2. **Describe** the magnetic field when two unlike magnetic poles are close together. Draw a diagram to illustrate your answer.

---

---

3. **Describe** how a compass needle moves when it is placed in a magnetic field.

---

---

4. **Explain** why only certain materials are magnetic.

---

---

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---

5. **Explain** how heating a bar magnet would change its magnetic field.

---

---

6. **Explain** Use the magnetic domain model to explain why a magnet sticks to a refrigerator door.

---

---

7. **Math Connection** Magnetic domains have an average volume of  $0.0001 \text{ mm}^3$ . If a magnet has dimensions of 50 mm by 10 mm by 4 mm, how many domains does the magnet contain?

---

# Magnetism and Its Uses

## 2 Electricity and Magnetism

### REVIEW VOCABULARY

electric current

Recall the definition of the Review Vocabulary term.

electric current

### NEW VOCABULARY

electromagnetic force

electromagnetism

solenoid

electromagnet

galvanometer

electric motor

Use your book to define each term.

electromagnetic force

electromagnetism

solenoid

electromagnet

galvanometer

electric motor

## 2 Electricity and Magnetism (continued)

**Evaluate** the magnetic fields that surround two identical pieces of wire carrying the same electric current. One wire is straight, and the other wire is coiled into a solenoid.

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---

**Get It? Explain** how the strength of the magnetic field around a wire can be increased.

---

---

**Get It? Compare and contrast** permanent magnets and electromagnets.

---

---

---

## 2 Electricity and Magnetism (continued)

**Sequence** the steps in the explanation of how electromagnets make sound when you listen to a CD. Some terms from the word bank may be used more than once.

amount                      current                      direction                      electromagnet  
magnetic field                      repelled                      reproduces                      voltage

The CD player produces a \_\_\_\_\_.

The \_\_\_\_\_ produces an electric \_\_\_\_\_ in the electromagnet next to the speaker cone.

The CD contains information that changes the \_\_\_\_\_ of current and its \_\_\_\_\_.

The changing electric current changes the direction and strength of the \_\_\_\_\_ around the electromagnet.

The electromagnet is attracted to or \_\_\_\_\_ by the permanent magnet.

The moving \_\_\_\_\_ vibrates the speaker cone and \_\_\_\_\_ the sound recorded on the CD.

**Get It? Summarize** how a stereo speaker uses an electromagnet to produce sound.

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## 2 Electricity and Magnetism (continued)

**Model** and label a galvanometer and describe how it works.

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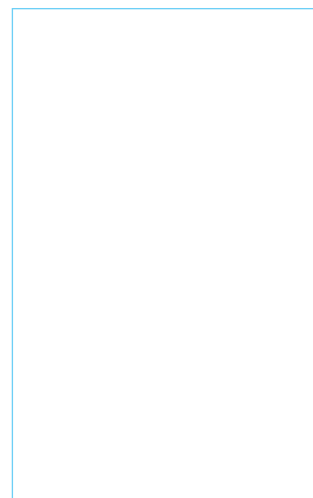
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**Sequence** the steps an electric motor uses to change electrical energy to mechanical energy. Make a sketch and label the motor.

1.

---

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2.

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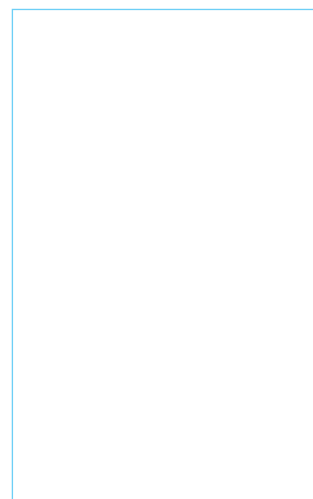
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3.

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## 2 Electricity and Magnetism (continued)

### CHECK YOUR PROGRESS

8. **Explain** what happens when a magnet is placed near a current-carrying wire.

---

---

9. **Infer** A bar magnet is repelled when an electromagnet is brought close to it. Describe how the bar magnet would have moved if the current in the electromagnet had been reversed.

---

10. **Define** the term *electromagnetic force*. Give an example of a machine that uses this force.

---

---

11. **Describe** two ways that you could increase the strength of the magnetic field produced by an electromagnet.

---

12. **Explain** how a simple electric motor transforms electrical energy into mechanical energy.

---

---

13. **Predict** How would an electromagnet's magnetic field change if the iron core were replaced by an aluminum core?

---

14. **Math Connection** The magnetic field around a current-carrying wire at a distance of 1 cm is twice as strong as at 2 cm. How does the field strength at 0.5 cm compare to the field strength at 1 cm?

---

# Magnetism and Its Uses

## 3 Producing Electric Current

### REVIEW VOCABULARY

voltage difference

Recall the definition of the Review Vocabulary term.

*voltage difference*

### NEW VOCABULARY

electromagnetic induction

generator

turbine

direct current (DC)

alternating current (AC)

transformer

Use your book to define each term.

*electromagnetic induction*

*generator*

*turbine*

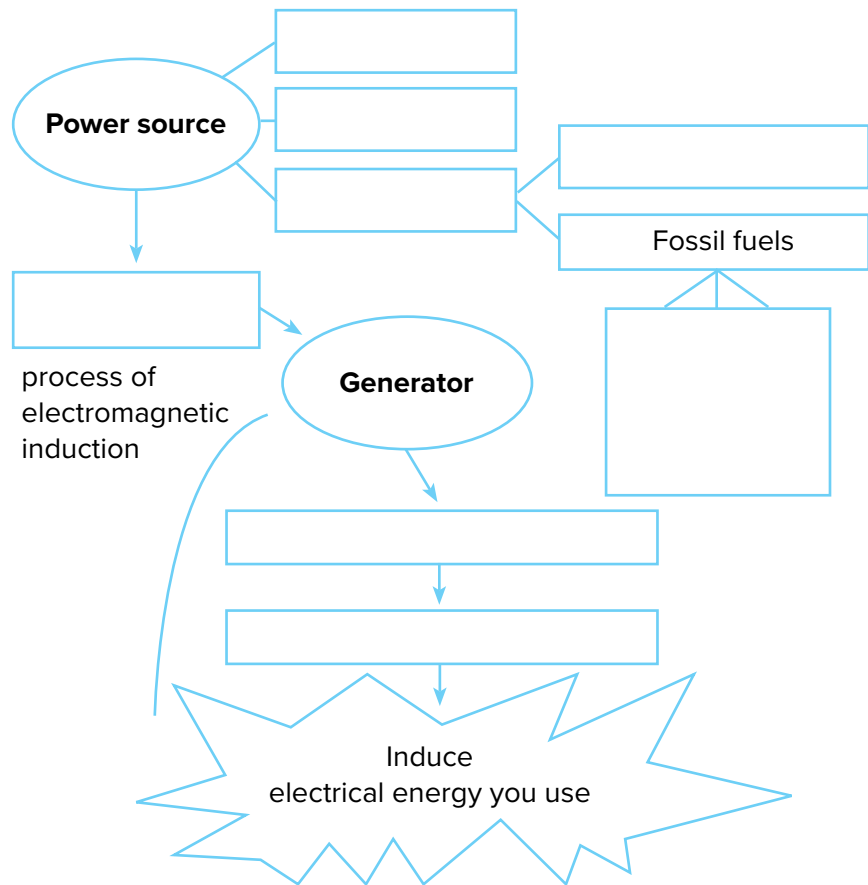
*direct current (DC)*

*alternating current (AC)*

*transformer*

### 3 Producing Electric Current (continued)

**Organize** the process of creating electrical energy from mechanical energy. Complete the concept map.



**Get It?** Define the term *electromagnetic induction*.

---

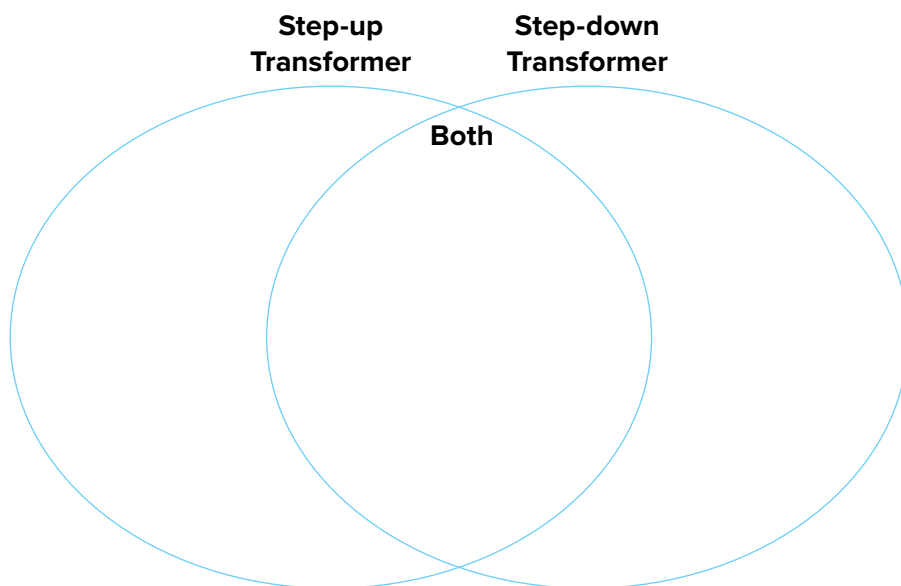
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### 3 Producing Electric Current (continued)

**Predict** three electrical devices in your home that will stop working in a power failure, and which devices will continue to work. Describe the two types of current used by these devices.

	Works	Doesn't Work
Devices		
Description of Current		

**Compare** the two types of transformers using a Venn diagram. List at least two pieces of information in each category.



**Analyze** why a transformer is needed to provide power to your home with the correct voltage.

---



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---

### 3 Producing Electric Current (continued)

#### CHECK YOUR PROGRESS

**18. Explain** why a magnet sitting next to a wire does not induce a current in the wire.

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---

**19. Define** the term *electromagnetic induction*, and explain how a generator uses electromagnetic induction.

---

---

---

**20. Describe** the difference between the current from a battery and the current from an electric socket.

---

---

**21. Summarize** the steps involved when a transformer changes the voltage of an alternating current.

---

---

**22. Explain** Why is the output voltage from a transformer zero if the current in the primary coil is a direct current?

---

---

**23. Math Connection** A transformer has 1000 turns of wire in the primary coil and 50 turns in the secondary coil. If the input voltage is 2400 V, what is the output voltage?

---

# 8 Energy Sources and the Environment

## ENCOUNTER THE PHENOMENON

Write the Encounter the Phenomenon question for this module.

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---

Use the “What I Know” column to list the things you know about the Encounter the Phenomenon question. Then list the questions you have about the Encounter the Phenomenon question in the “What I Want to Find Out” column. As you read the module, fill in the “What I Learned” column.

K <i>What I Know</i>	W <i>What I Want to Find Out</i>	L <i>What I Learned</i>

# Energy Sources and the Environment

## 1 Fossil Fuels

### REVIEW VOCABULARY

chemical potential energy

Recall the definition of the Review Vocabulary term.

*chemical potential energy*

### VOCABULARY

Write the correct vocabulary term in the left column for each definition below.

any fuel formed by the decay of ancient plants and animals

a liquid fuel that is a mixture of hydrocarbons formed by decayed organisms

a resource that cannot be replaced by natural processes as quickly as it is used



## 1 Fossil Fuels (continued)

**Analyze** the two graphs in **Figure 2** in your textbook to complete the statements.

More energy is used for \_\_\_\_\_ in the United States than for anything else. \_\_\_\_\_ users use about 12 percent less energy than industry. Petroleum and natural gas together supply \_\_\_\_\_ of our energy needs. Solar/geothermal, wind, and \_\_\_\_\_ together supply only about 6 percent of our energy needs. \_\_\_\_\_ supplies nearly 9 percent of energy needs in the United States. About 80 percent of the energy used comes from burning \_\_\_\_\_, \_\_\_\_\_, and \_\_\_\_\_.

**Estimate** the ratio of the energy content of wood to each of the other three types of energy. Use **Figure 3** in your textbook.

---

---

---

**Get It? Explain** how chemical compounds in petroleum are separated.

---

---

**Get It? Identify** four specific non-fuel items that you use every day that are made of petroleum-based materials.

---

---

---

## 1 Fossil Fuels (continued)

**Get It? Identify** advantages to using natural gas instead of petroleum or coal for energy.

---

---

**Get It? Describe** how coal forms.

---

---

**Complete** the following table to compare natural gas and coal.

Fuel	Description of Fuel	Main Use or Uses	Environmental Impact
Natural Gas			
Coal			

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**Get It? Identify** three examples of nonrenewable resources.

---

---

## 1 Fossil Fuels (continued)

**Explain** why only about 35 percent of the energy stored in fossil fuels burned in power plants is transported to where it can be used as electrical energy.

---

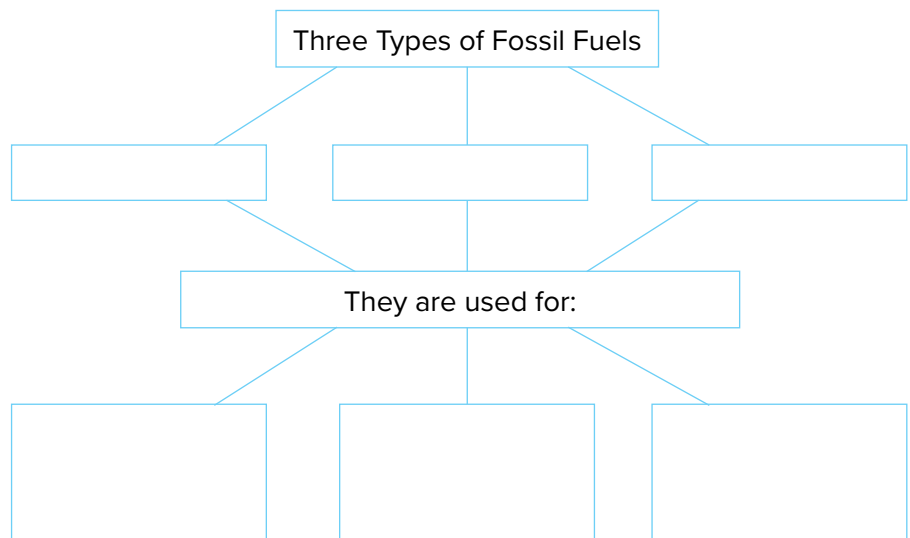
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**Complete** the sentences below.

Because fossil fuels are \_\_\_\_\_ resources, their supply is \_\_\_\_\_. As the human population grows and \_\_\_\_\_ demands \_\_\_\_\_, reserves are \_\_\_\_\_. This means that \_\_\_\_\_ the remaining supplies is very important. Another reason to reduce the use of fossil fuels is that they release \_\_\_\_\_ into the environment when burned, which contributes to \_\_\_\_\_.

**Summarize** the types and uses of fossil fuels by completing the diagram.



## 1 Fossil Fuels (continued)

### CHECK YOUR PROGRESS

1. **Describe** the advantages and disadvantages of using fossil fuels to generate electricity.

---

---

2. **Explain** how you use energy resources daily.

---

---

3. **Describe** how fossil fuels are formed.

---

---

4. **Explain** the law of conservation of energy as it applies to the burning of fossil fuels.

---

---

5. **Explain** Why are fossil fuels considered to be a nonrenewable resource?

---

---

6. **Math Connection** According to the graph in **Figure 8** (in your book), by how many parts per million did the concentration of atmospheric carbon dioxide increase from 1958 to 2010?

---

---

7. **Math Connection** Use a Graph According to the graph in **Figure 3** (in your book), about how much more energy is released by burning 1 g of natural gas compared to burning 1 g of wood?

---

---

# Energy Sources and the Environment

## 2 Nuclear Energy

### REVIEW VOCABULARY

generator

Recall the definition of the Review Vocabulary term.

generator

### VOCABULARY

Write the correct vocabulary term in the left column for each definition below.

process in which atomic nuclei combine at very high temperatures, resulting in a small amount of mass being converted to a large amount of thermal energy

process in which a small amount of mass energy is converted into a tremendous amount of thermal energy by splitting nuclei

system that generates electricity from controlled nuclear reactions

any radioactive by-product of the use of radioactive materials

## 2 Nuclear Energy (continued)

**Identify** three advantages and three disadvantages of using fusion.

Advantages	Disadvantages
1.	1.
2.	2.
3.	3.

**Analyze** nuclear energy use by filling in the correct numeral for each statement.

\_\_\_\_\_ number of power plants in the United States

\_\_\_\_\_ percent of energy consumed in the United States  
that is produced from nuclear power

**Describe** the four common parts of all nuclear reactors.

1. \_\_\_\_\_
2. \_\_\_\_\_
3. \_\_\_\_\_
4. \_\_\_\_\_

**Sequence** a uranium nuclear fission reaction by completing the flow chart below. The first step has been done for you.

1. A neutron hits the nucleus of a U-235 atom.



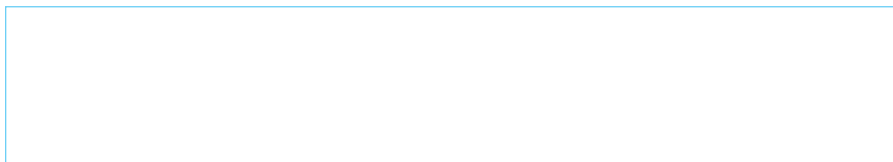
2.



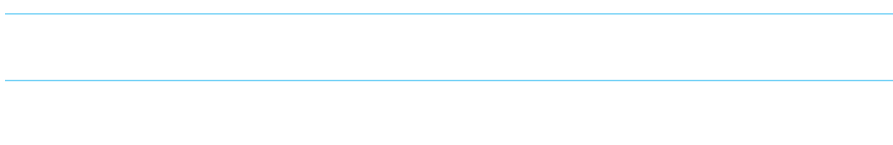
3.

## 2 Nuclear Energy (continued)

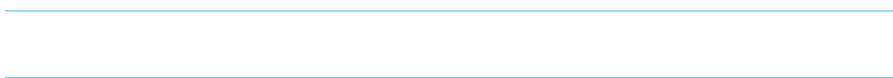
**Model** and label the control rods in a nuclear reactor. Use arrows to show how the rods would be moved to slow the reaction.



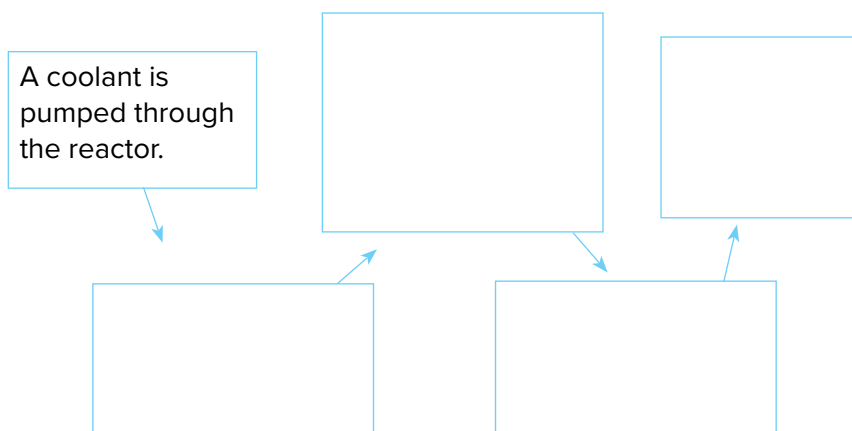
**Get It? Explain** how a nuclear chain reaction is controlled in a nuclear reactor.



**Predict** what would happen if the control rods were completely removed from a nuclear reaction.



**Complete** the graphic organizer to explain how nuclear fission produces electricity.



## 2 Nuclear Energy (continued)

**Get It? Explain** how nuclear power plants produce an electric current.

---

---

---

**Get It? Describe** the formation of spent fuel.

---

---

**Get It? Identify** industries that produce low-level waste.

---

---

**Get It? Describe** What are the differences between low-level and high-level nuclear wastes?

---

---

**Compare and contrast** nuclear fusion and nuclear fission.

---

---

---



## 2 Nuclear Energy (continued)

### CHECK YOUR PROGRESS

8. **Compare and contrast** the advantages and disadvantages of nuclear power plants and those that burn fossil fuels.

---

---

---

9. **Describe** nuclear fission and how the chain reaction in a nuclear reactor is controlled.

---

---

---

10. **Describe** nuclear fusion and the problems associated with using nuclear fusion reactions as an energy source.

---

---

---

11. **Explain** why a chain reaction occurs when uranium-235 undergoes fission.

---

---

12. **Classify** A research project produced 10 g of nuclear waste with a short half-life. How would you classify this waste, and how would it be disposed?

---

13. **Math Connection** Naturally occurring uranium contains 0.72 percent of the isotope uranium-235. What is the mass of uranium-235 in 2,000 kg of naturally occurring uranium?

---

# Energy Sources and the Environment

## 3 Renewable Energy Resources

### REVIEW VOCABULARY

radiant energy

Recall the definition of the Review Vocabulary term.

radiant energy

### VOCABULARY

renewable resource

photovoltaic cell

hydroelectricity

geothermal energy

biomass

Use your book to define each term.

renewable resource

photovoltaic cell

hydroelectricity

geothermal energy

biomass

### 3 Renewable Energy Resources (continued)

**Summarize** the need for alternative energy resources.

---

---

---

---

**Complete** the statements to make them true.

The solar energy reaching the United States in one year is equal to \_\_\_\_\_ times the energy used in the United States in one year. When sunlight strikes a solar cell, \_\_\_\_\_ flow through a circuit. Conversion of solar energy to electrical energy by solar cells is only about \_\_\_\_\_ percent efficient. In a parabolic trough, sunlight is focused on a tube that contains a \_\_\_\_\_ fluid. The heated fluid produces \_\_\_\_\_, which turns a turbine to generate an \_\_\_\_\_.

**Get It? Explain** how the structure and materials of solar cells enables them to transform radiant energy into electrical energy.

---

---

---

---

### 3 Renewable Energy Resources (continued)

**Sequence** the steps in the production of hydroelectric energy. The first step has been completed for you.

Water flows through tunnels near the base of a dam.
↓
↓
↓

**Complete** the table comparing information about tides, wind, and geothermal energy resources.

	Tides	Wind	Geothermal
availability of the resource			
effect on plants and animals			
pollution created			

**Identify** two alternative fuels.

---

**Evaluate** one renewable energy resource that you think is promising as a way to supply our future energy needs. Support your choice.

---

---

### 3 Renewable Energy Resources (continued)

#### CHECK YOUR PROGRESS

**14. Explain** the need to develop and use alternative energy sources.

---

---

---

**15. Describe** three ways that solar energy can be used.

---

---

**16. Explain** how the generation of electricity by hydroelectric, tidal, and wind sources are similar to each other.

---

---

**17. Infer** why geothermal energy is unlikely to become a major energy source.

---

**18. Analyze** On what single energy source do most energy alternatives depend, either directly or indirectly?

---

---

---

**19. Math Connection** A house uses solar cells that generate 1.5 kW of electrical power to supply some of its energy needs. If the solar panels supply the house with 40 percent of the power it needs, how much power does the house use?

---

# Energy Sources and the Environment

## 4 Environmental Impacts

### REVIEW VOCABULARY

temperature

Recall the definition of the Review Vocabulary term.

temperature

### VOCABULARY

population

carrying capacity

pollutant

hazardous waste

photochemical smog

acid precipitation

Use your book to define each term.

population

carrying capacity

pollutant

hazardous waste

photochemical smog

acid precipitation

## 4 Environmental Impacts (continued)

**Model** population growth of modern humans by creating a graph on the grid provided below. First, use **Figure 25** in your textbook to complete the facts given in these five sentences.

1. Human population was \_\_\_\_\_ in the year 1700.
2. Human population first reached 1 billion in the year \_\_\_\_\_.
3. In 1960, the human population was \_\_\_\_\_.
4. Human population reached 6.8 billion in \_\_\_\_\_.
5. The population is expected to reach \_\_\_\_\_ by 2050.


**Define** carrying capacity. Hypothesize about some factors that threaten carrying capacity and things humans could do to increase our carrying capacity.

Carrying Capacity		
Definition	Limits	Ways to increase it

## 4 Environmental Impacts (continued)

**Complete** the chart to show how some of your daily activities consume resources and affect the environment.

How My Activities Affect the Environment	
Activity	Effect on Environment

**Organize** information about land usage in the outline. Two examples have been filled in for you.

### Land Uses and Their Environmental Problems

#### A. Agriculture

1. \_\_\_\_\_
2. Increases soil erosion.

#### B. Forest resource use

1. \_\_\_\_\_
2. \_\_\_\_\_

#### C. Urban Development

1. Paving stops water from soaking into soil, causing flooding.
2. \_\_\_\_\_

#### D. Waste

1. \_\_\_\_\_
2. \_\_\_\_\_



## 4 Environmental Impacts (continued)

**Summarize** the effects of each source of water pollution by completing the chart.

Sources of Water Pollution and Their Effects	
Source	Effects
Sediment	
Metals	
Oil and gasoline	
Human waste/ sewage	

**Get It?** **List** the sources of land, water, and air pollution.

---

---

**Sequence** steps in the formation of smog.

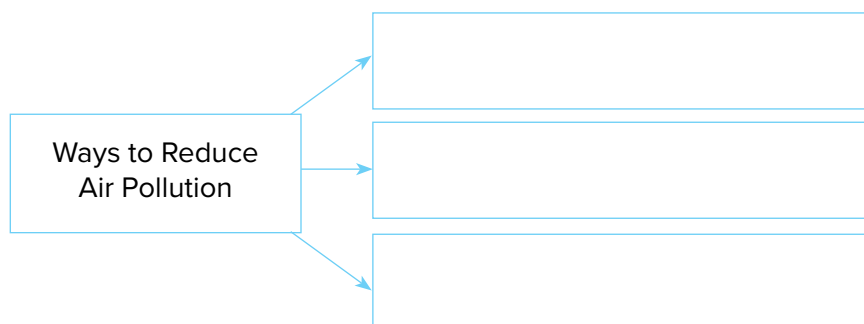
1.	
2.	
3.	
4.	

## 4 Environmental Impacts (continued)

**Create** an original drawing in the box to show how acid rain forms. Add labels to your drawing to identify what it shows.



**Complete** the graphic organizer about reducing air pollution.



**Infer** Why would setting the thermostat in your home at a lower temperature in winter and a higher temperature in summer help reduce air pollution?

---

---

---

## 4 Environmental Impacts (continued)

### CHECK YOUR PROGRESS

**20. Discuss** what you can do to lessen your environmental impact on natural resources such as land, water, and air.

---

---

---

**21. Describe** how urban development can increase flooding.

---

---

**22. Infer** the effect of deforestation on the carrying capacity of the Amazon rain forest.

---

---

---

**23. Identify** three pollutants released into the air when fossil fuels are burned.

---

**24. Infer** Southern Florida is home to many dairy and sugarcane farms. Everglades National Park, including its shallow river system, is also located there. What kinds of pollutants might affect plants and animals in the Everglades?

---

---

**25. Math Connection** A decrease of one unit on the pH scale means a solution is ten times more acidic. A decrease of two units means the solution is 100 times more acidic. How much more acidic is acid precipitation ( $\text{pH} = 4.0$ ) than pure water ( $\text{pH} = 7.0$ )?

---



# 9 Introduction to Waves

## ENCOUNTER THE PHENOMENON

Write the Encounter the Phenomenon question for this module.

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---

---

Use the “What I Know” column to list the things you know about the Encounter the Phenomenon question. Then list the questions you have about the Encounter the Phenomenon question in the “What I Want to Find Out” column. As you read the module, fill in the “What I Learned” column.

K <i>What I Know</i>	W <i>What I Want to Find Out</i>	L <i>What I Learned</i>

# Introduction to Waves

## 1 The Nature of Waves

### REVIEW VOCABULARY

matter

Recall the definition of the Review Vocabulary term.

*matter*

### NEW VOCABULARY

wave

medium

mechanical wave

transverse wave

longitudinal wave

Use your book to define each term.

*wave*

*medium*

*mechanical wave*

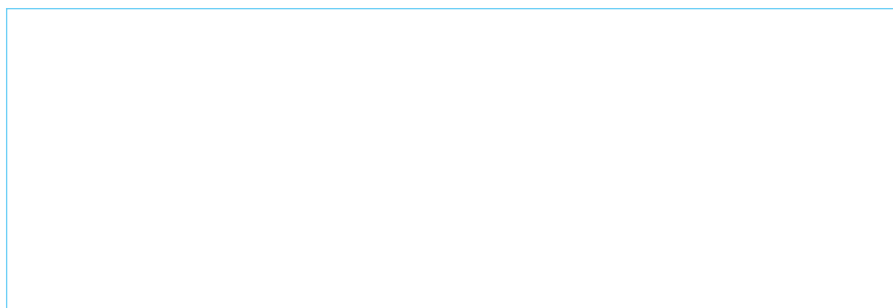
*transverse wave*

*longitudinal wave*

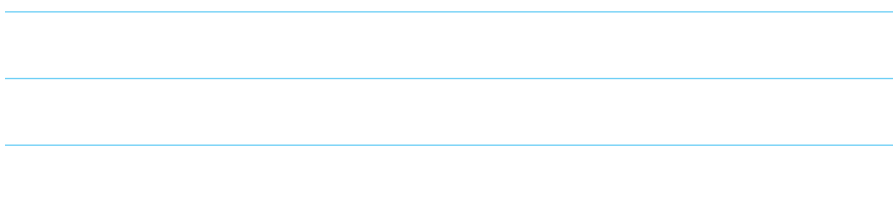
## 1 The Nature of Waves (continued)

**Model** energy transfer in waves.

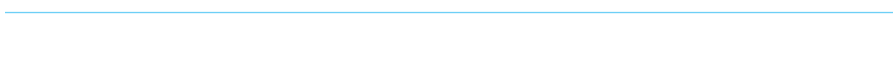
- Draw a sketch of a pebble being dropped in the water and creating waves.
- Draw arrows to show the direction of the energy that is being transferred by the waves.



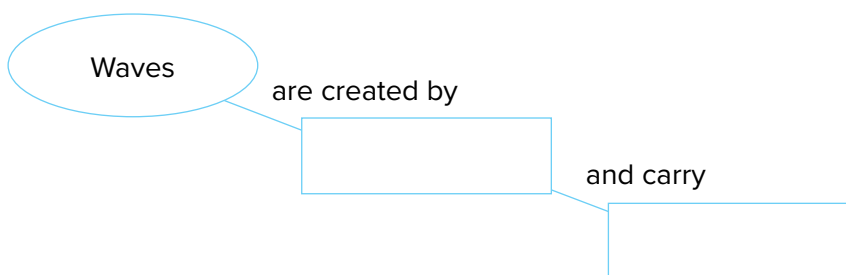
**Analyze** what happens when waves come into contact with a boat. Explain why they do not move the boat to a different position.



**Get It? Identify** what waves carry.



**Complete** the graphic organizer about waves.



## 1 The Nature of Waves (continued)

**Get It? Describe** what happens to the energy carried by a water wave.

---

---

**Get It? Identify** what produces waves.

---

---

**Classify** each type of wave as a mechanical wave or not.

Type of Wave	Is it a mechanical wave?
ocean wave	
sound wave	
radio wave	
light wave	

**Get It? Describe** the connection between a medium and a mechanical wave.

---

---

**Get It? Compare** the direction that a transverse wave travels with the direction that matter in that wave vibrates.

---

---



## 1 The Nature of Waves (continued)

**Compare and contrast** the 2 types of mechanical waves.

- Draw an example of each wave.
- Use arrows to show the direction each wave travels and how transverse and longitudinal waves each move the medium.



**Get It? Describe** how sound waves travel through solids.

---

---

## 1 The Nature of Waves (continued)

### CHECK YOUR PROGRESS

1. **Describe** the motion of an unanchored rowboat when a water wave passes. Does the wave move the boat forward?

---

---

---

2. **Contrast** how you would move a spring to make a transverse wave with how you would move a spring to make a longitudinal wave.

---

---

---

3. **Identify** evidence that seismic waves transfer energy without transferring matter.

---

---

---

4. **Identify** a mechanical wave that is also a longitudinal wave.

---

---

---

5. **Describe** how the world would be different if all waves were mechanical waves.

---

---

---

6. **Math Connection** The average speed of sound in water is 1500 m/s. How long would it take a sound wave to travel 9000 m in water?

---

---

# Introduction to Waves

## 2 Wave Properties

### REVIEW VOCABULARY

vibration

Recall the definition of the Review Vocabulary term.

vibration

### NEW VOCABULARY

crest

trough

compression

rarefaction

wavelength

frequency

period

amplitude

Use your book to define each term.

crest

trough

compression

rarefaction

wavelength

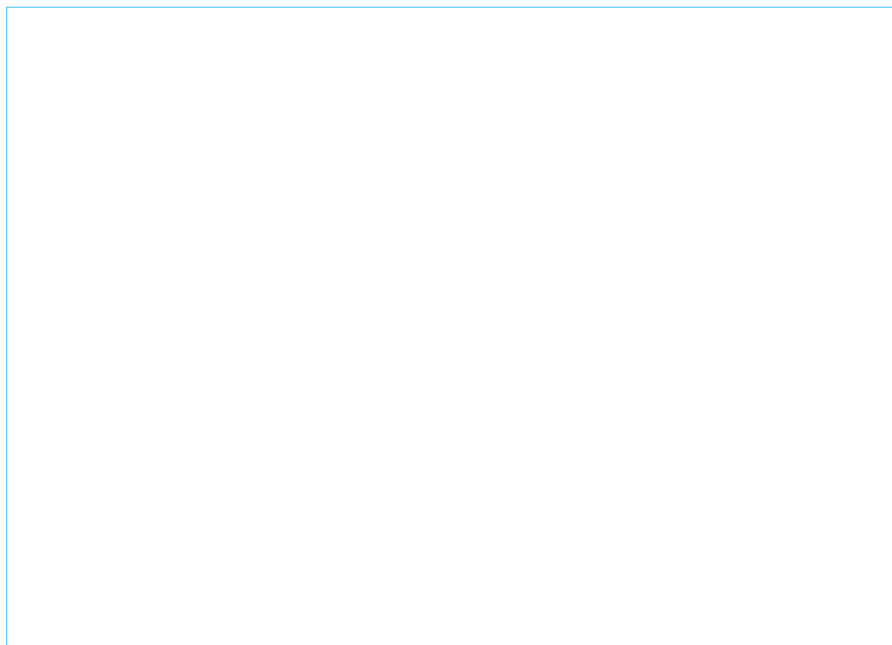
frequency

period

amplitude

## 2 Wave Properties (continued)

**Model** two transverse waves. Make the wavelength of one three times as long as the other. Identify a crest, trough, and wavelength for each wave.



**Model** two longitudinal waves, one with a wavelength twice as long as the other. Identify a rarefaction and compression in each wave. Label the wavelength.



## 2 Wave Properties (continued)

**Get It? Describe** how wavelength is defined for transverse waves and for longitudinal waves.

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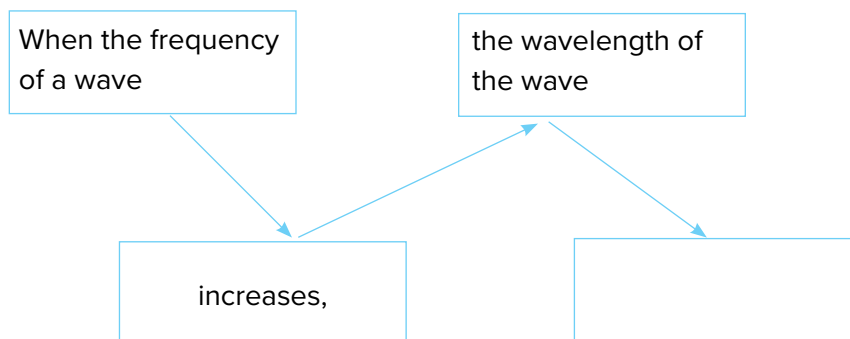
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**Get It? Describe** how the wavelength and the frequency of a wave are related.

---

---

**Complete** the flow chart to help you understand the relationship between frequency and wavelength.



## 2 Wave Properties (continued)

**Evaluate** the speed of an ocean wave that has a wavelength of 4.0 m and a frequency of 400 Hz.

$f = \underline{\hspace{2cm}}$	$\lambda = \underline{\hspace{2cm}}$
$v = f \times \lambda$ $v = \underline{\hspace{1cm}} \times \underline{\hspace{1cm}}$ $v = \underline{\hspace{1cm}} \text{ m/s}$	

**Get It? Identify** Based on the equation, how would the wavelength of a wave be affected if the speed of the wave doubles but the frequency of the wave stays the same?

---

**Compare** two longitudinal waves by drawing them. One wave should have more energy than the other. Label the energy of each wave.

**Identify** how the amplitude of a transverse wave is measured. Make a sketch to show your answer.

## 2 Wave Properties (continued)

### CHECK YOUR PROGRESS

11. **Identify** a wave that speeds up when it passes from air to water as well as one that slows down.

---

---

12. **Describe** the difference between a longitudinal wave with a large amplitude and one with a small amplitude.

---

---

---

13. **Describe** how the wavelength of a wave changes if the wave slows down but its frequency does not change.

---

---

14. **Explain** how the frequency of a wave changes when the period of the wave increases.

---

---

15. **Explain** You make a transverse wave by shaking the end of a long rope up and down. Explain how you would shake the end of the rope to make the wavelength shorter.

---

---

16. **Math Connection** Calculate the frequency of a water wave that has a wavelength of 0.5 m and a speed of 4 m/s.

---

---

17. **Math Connection** An FM radio station broadcasts radio waves with a frequency of 96,000,000 Hz. What is the speed of these radio waves if they have a wavelength of 3.1 m?

---

# Introduction to Waves

## 3 The Behavior of Waves

### REVIEW VOCABULARY

perpendicular

Recall the definition of the Review Vocabulary term.

perpendicular

### NEW VOCABULARY

refraction

diffraction

interference

standing wave

node

resonance

Use your book to define each term.

refraction

diffraction

interference

standing wave

node

resonance



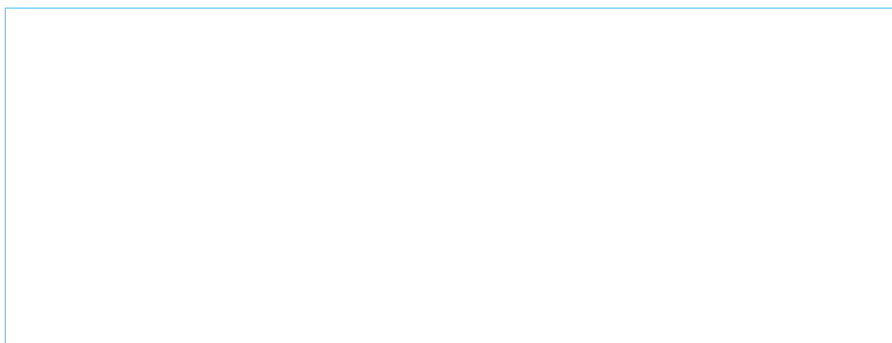
### 3 The Behavior of Waves (continued)

**Summarize** the law of reflection by completing the sentence below.

The angle of \_\_\_\_\_ is equal to \_\_\_\_\_.

**Create** a diagram showing a flashlight shining on a mirror. Label your diagram with the terms given.

- angle of incidence
- angle of reflection
- incident beam
- reflected beam
- the normal



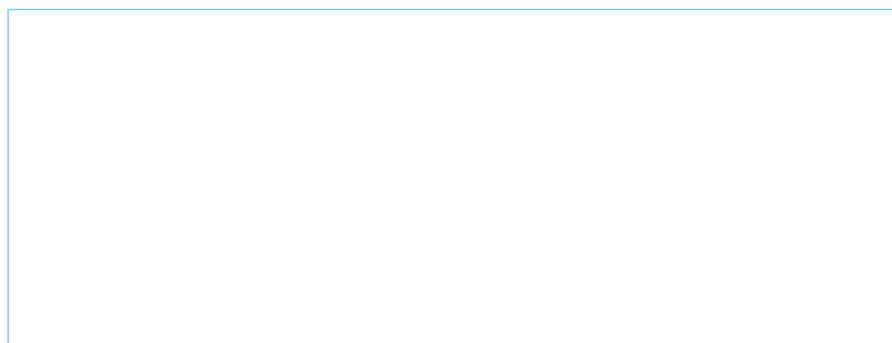
**Summarize** why a spoon placed in a clear glass of water appears to be crooked. Make a sketch to help you explain.

---

---

---

---



### 3 The Behavior of Waves (continued)

**Get It? Explain** Refraction is responsible for many optical illusions. How is your brain fooled into seeing a broken straw?

---

---

---

**Get It? Compare** how light would respond differently when striking an object that is not transparent than when striking an object that is transparent, such as a glass window.

---

---

**Evaluate** one similarity and one difference between refraction and diffraction.

Similarity	Difference

**Get It? Contrast** refraction with diffraction.

---

---

**Get It? Describe** What are two situations in which a wave will diffract?

---

---

### 3 The Behavior of Waves (continued)

**Get It? Describe** the effect of wavelength and object size on the diffraction of a wave.

---

---

---

---

**Get It? Compare** the diffraction of FM radio waves with the diffraction of AM radio waves.

---

---

**Complete** the table describing the 2 types of interference.

Interference	Interference
Cause:	Cause:
Result:	Result:

### 3 The Behavior of Waves (continued)

**Get It? Describe** the effects of constructive interference and destructive interference on the amplitude of a wave.

---

---

---

---

**Summarize** what causes a standing wave to form.

---

---

**Analyze** why an opera singer singing a high note into a microphone can cause a nearby glass of water to shatter.

---

---

---

---

---

### 3 The Behavior of Waves (continued)

#### CHECK YOUR PROGRESS

**18. Describe** the path that light waves take when you see your image in a mirror.

---

---

---

**19. Compare** the loudness of sound waves that constructively interfere with the loudness of sound waves that destructively interfere.

---

---

---

**20. Describe** how one tuning fork's vibrations can cause another tuning fork to vibrate.

---

---

---

**21. Infer** Sound waves often bend around columns in large concert halls. Is this a result of refraction or diffraction?

---

---

---

**22. Model** Suppose the speed of light was greater in water than in air. Draw a diagram to show whether an object under water would seem deeper or closer to the surface than it actually is.

---

---

---

**23. Math Connection** The angle between a flashlight beam that strikes a mirror and the reflected beam is 80 degrees. What is the angle of incidence?

---



# 10 Sound

## ENCOUNTER THE PHENOMENON

Write the Encounter the Phenomenon question for this module.

Use the “What I Know” column to list the things you know about the Encounter the Phenomenon question. Then list the questions you have about the Encounter the Phenomenon question in the “What I Want to Find Out” column. As you read the module, fill in the “What I Learned” column.

K <i>What I Know</i>	W <i>What I Want to Find Out</i>	L <i>What I Learned</i>

# Sound

## 1 The Nature of Sound

### REVIEW VOCABULARY

amplify

Recall the definition of the Review Vocabulary term.

amplify

### NEW VOCABULARY

eardrum

cochlea

Use your book to define each term.

eardrum

cochlea



## 1 The Nature of Sound (continued)

**Complete** the diagram showing what vibrates to produce each sound on the right.

	→	music from a stereo
	→	people speaking
	→	all sound

**Sequence** the steps involved in creating a sound wave from a speaker. The steps are written in scrambled order on the left. Write the steps in the correct order in the boxes on the right.

The air molecules collide with other air molecules.	1.
A speaker moves outward.	2.
A rarefaction forms behind the compression.	3.
A compression forms.	4.
Energy is transferred from the speaker to these air molecules.	5.
The speaker collides with nearby air molecules.	6.
The speaker moves inward.	7.

**Organize** Place the words liquid, solid, and gas on the continuum below. Describe how close particles are to each other in each phase.

sound travels slowest		sound travels fastest
←	→	

## 1 The Nature of Sound (continued)

**Get It? Identify** two reasons why sounds usually travel faster through solids than through gases.

---

---

**Compare** the speed of the sound of a child yelling outside when it is 10°C to the speed of the same sound when it is 30°C.


---

---

---

**Create** your own sketch of an ear. Label the following parts and describe what each part of the ear does to enable you to hear.

- |             |           |              |
|-------------|-----------|--------------|
| • anvil     | • eardrum | • outer ear  |
| • cochlea   | • hammer  | • middle ear |
| • ear canal | • stirrup | • inner ear  |



**Get It? Identify** what makes the eardrum vibrate.

---

---

## 1 The Nature of Sound (continued)

### CHECK YOUR PROGRESS

1. **Explain** how sound travels from your vocal cords to your friend's ears when you talk.

---

---

2. **Summarize** the physical reasons that sound waves travel at different speeds through different mediums.

---

---

3. **Explain** why sound speeds up when temperature increases.

---

---

4. **Describe** each section of the human ear and its role in hearing.

---

---

---

5. **Hypothesize** Form a hypothesis to explain why some people hear a ringing in their ears (tinnitus) in the absence of sound.

---

---

6. **Math Connection** Using **Table 1** from your textbook, calculate how long it takes a sound wave to travel 1.0 km through air when the temperature is  $0.0^{\circ}\text{C}$ .

---

---

7. **Math Connection** How long does it take the same wave to travel 1.0 km in air at  $20.0^{\circ}\text{C}$ ?

---

---

# Sound

## 2 Properties of Sound

### REVIEW VOCABULARY

frequency

Recall the definition of the Review Vocabulary term.

frequency

### NEW VOCABULARY

intensity

loudness

decibel

pitch

Doppler effect

Use your book to define each term.

intensity

loudness

decibel

pitch

Doppler effect

## 2 Properties of Sound (continued)

**Create** density drawings of particles in sound waves with a low level of intensity and a high level of intensity. Label a rarefaction and a compression in each drawing.

Low Intensity	
High Intensity	

**Compare** the energy and travel distance of high-intensity sound waves and low-intensity sound waves.

---

---

**Get It? Relate** intensity and loudness.

---

---

**Complete** the following paragraph to summarize loudness.

The perception of sound intensity is \_\_\_\_\_. Loud sounds come from sound waves that have \_\_\_\_\_ intensity and \_\_\_\_\_. When these sound waves reach your ear, they cause your \_\_\_\_\_ to vibrate more than sound waves with \_\_\_\_\_ intensity.

## 2 Properties of Sound (continued)

**Identify** the following key characteristics of sound intensity.

units of sound intensity \_\_\_\_\_

level of faintest sound humans can hear \_\_\_\_\_

sustained sound level that damages human hearing \_\_\_\_\_

short-duration sound level that can cause pain \_\_\_\_\_

**Complete** the following paragraph to summarize pitch.

Pitch is how \_\_\_\_\_ or \_\_\_\_\_ a sound seems to be. Pitch depends primarily on the \_\_\_\_\_ of sound waves. High-pitched sounds are caused by sound waves with \_\_\_\_\_ frequencies. Low-pitched sounds are caused by sound waves with \_\_\_\_\_ frequencies. A human teenager with typical hearing can hear sounds with frequencies from about \_\_\_\_\_ to about \_\_\_\_\_.

**Organize** information about the Doppler effect in the following table.

Motion of source relative to observer	Toward	Away from
Compressions are...	closer together	
Frequency is...		
Pitch is...		

**Get It?** Describe the Doppler effect.

---

---

## 2 Properties of Sound (continued)

### CHECK YOUR PROGRESS

8. **Determine** which will change if you turn up a radio's volume: *wave velocity, intensity, pitch, frequency, wavelength, loudness*. Explain.

---

---

9. **Identify** the range of human hearing in decibels and the level at which sound can damage human ears.

---

---

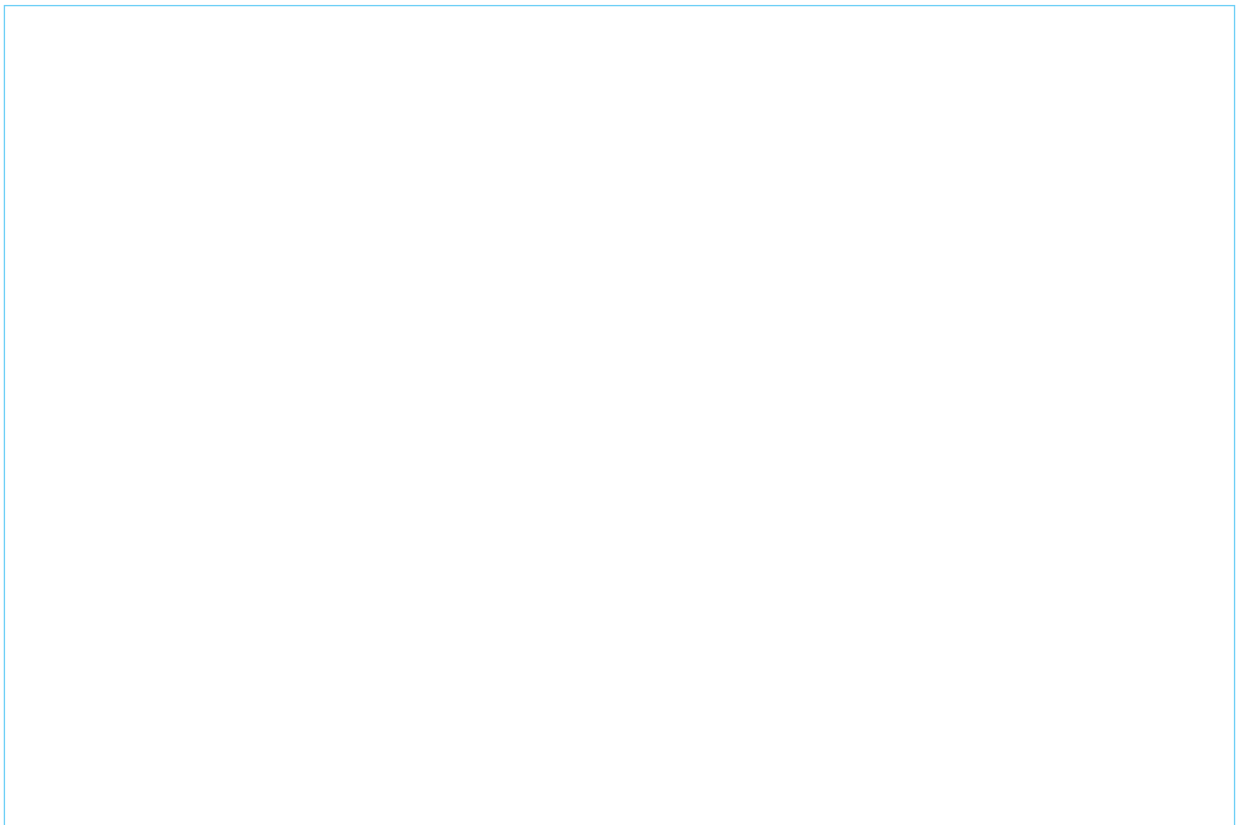
10. **Compare and contrast** frequency and pitch.

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---

---

11. **Draw and label** a diagram that explains the Doppler effect.



## 2 Properties of Sound (continued)

- 12. Explain** why a passing car would exhibit a greater sound frequency change when it moves at 30 m/s than when it moves at 12 m/s.

---

---

---

- 13. Math Connection** Using the musical scale in **Figure 9**, make a table showing how many wavelengths will pass you in one minute for each note. What is the relationship between frequency and the number of wavelengths per minute?

Note	Frequency	Wavelengths per minute
C		
D		
E		
F		
G		
A		
B		
C		

---

---



# Sound

## 3 Music

### REVIEW VOCABULARY

resonance

Recall the definition of the Review Vocabulary term.

resonance

### NEW VOCABULARY

music

sound quality

overtone

resonator

Use your book to define each term.

music

sound quality

overtone

resonator

### 3 Music (continued)

**Get It? Explain** the difference between music and noise.

---

---

---

**Get It? Compare** sound quality and pitch.

---

---

---

**Summarize** the relationship between overtones and sound quality by completing the paragraph below.

Each instrument has its own sound quality. When you play a note on an instrument, the \_\_\_\_\_ of the note you hear is the \_\_\_\_\_ frequency. The instrument also vibrates at other frequencies called \_\_\_\_\_. These are vibrations whose frequencies are \_\_\_\_\_ of the fundamental frequency. The sound quality of the note depends on the relative \_\_\_\_\_ of the overtones.

### 3 Music (continued)

**Complete** the table showing the different types of musical instruments and how they produce sound.

Type of Instrument	How is sound produced?	What is the resonator?	Examples
Strings			
Woodwinds and brass			
Percussion			

**Explain** what beats are and how their frequency is calculated.

---

---

---

---

### 3 Music (continued)

#### CHECK YOUR PROGRESS

**14. Compare and contrast** music and noise.

---

---

**15. Explain** how two instruments could be used to produce a pulsing sound, and identify the name for this pulsing sound.

---

---

**16. Describe** how a flute, violin, and drum each produce sound.

---

---

---

**17. Explain** how two musical notes that have the same pitch and volume could sound very different from each other.

---

---

**18. Math Connection** A guitar string vibrates with a frequency of 440 Hz. When a second string is played at the same time, two beats per second are heard. What are the possible frequencies of vibration of the second string?

---

# Sound

## 4 Using Sound

### REVIEW VOCABULARY

echo

Recall the definition of the Review Vocabulary term.

echo

### NEW VOCABULARY

acoustics

echolocation

sonar

ultrasound

Use your book to define each term.

acoustics

echolocation

sonar

ultrasound

## 4 Using Sound (continued)

**Summarize** three characteristics of a room that can affect reverberation. List three materials or ways to reduce reverberation.

**Factors that Affect  
Reverberation**

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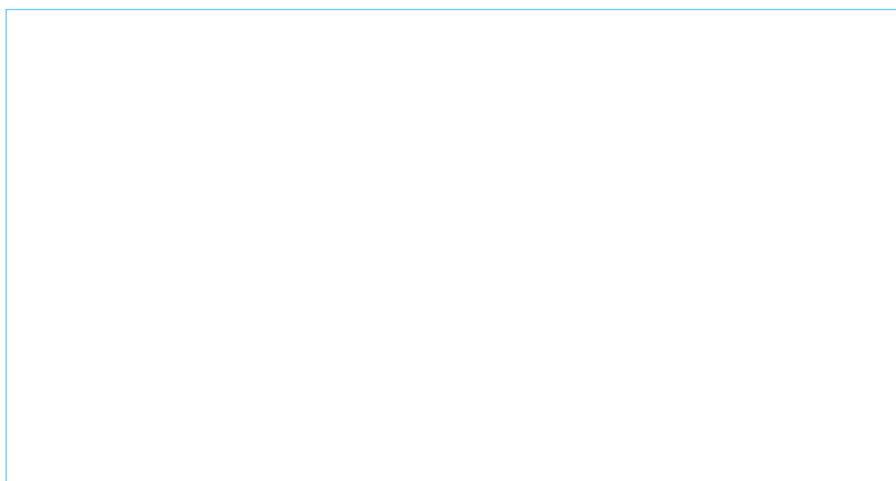
**Ways to Reduce  
Reverberation**

---

---

---

**Draw** a diagram of a bat using echolocation to identify an insect. Be sure to include the sound waves being sent from the bat and reflecting to the bat from the insect.



**Get It? Describe** how sonar detects underwater objects.

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## 4 Using Sound (continued)

**Identify** four uses of sonar.

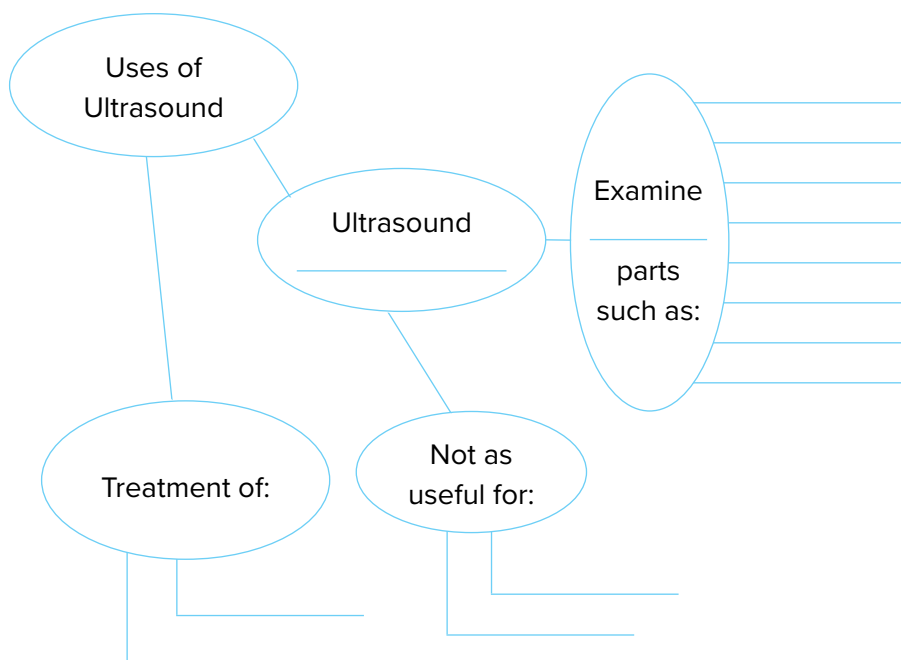
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---

**Organize** information about the uses of ultrasound in medicine by completing the concept map.



## 4 Using Sound (continued)

### CHECK YOUR PROGRESS

**19. Describe** at least three different ways that people use sound.

---

---

**20. Describe** some differences between a gym and a concert hall that might affect the amount of reverberation in each.

---

---

**21. Compare and contrast** echolocation and sonar.

---

---

**22. Explain** how ultrasonic imaging works.

---

---

---

**23. Apply** How might sonar technology be useful in locating deposits of oil and minerals?

---

---

**24. Math Connection** Sound travels at about 1500 m/s in seawater. How far will an undersea sonar pulse travel in 46 s?

---

**25. Math Connection** How long will it take for an undersea sonar pulse to travel 3 km?

---



# 11 Electromagnetic Waves

## ENCOUNTER THE PHENOMENON

Write the Encounter the Phenomenon question for this module.

Use the “What I Know” column to list the things you know about the Encounter the Phenomenon question. Then list the questions you have about the Encounter the Phenomenon question in the “What I Want to Find Out” column. As you read the module, fill in the “What I Learned” column.

K <i>What I Know</i>	W <i>What I Want to Find Out</i>	L <i>What I Learned</i>

# Electromagnetic Waves

## 1 What are electromagnetic waves?

### REVIEW VOCABULARY

magnetic field

Recall the definition of the Review Vocabulary term.

magnetic field

### NEW VOCABULARY

electromagnetic wave

photon

Use your book to define each term.

electromagnetic wave

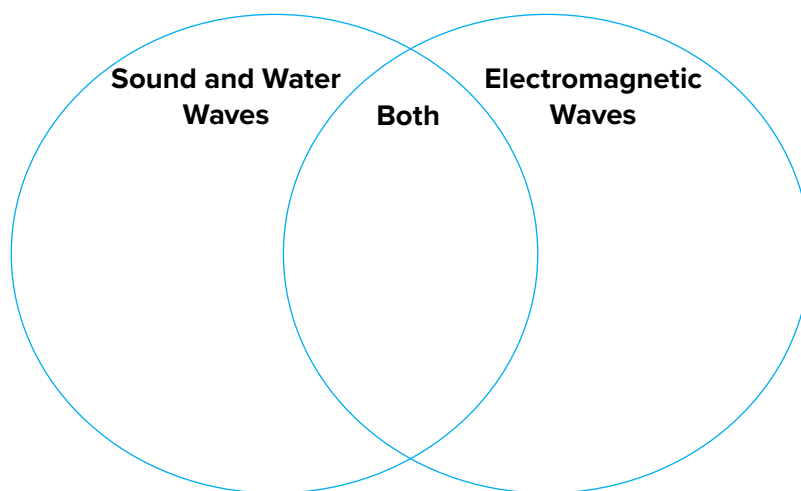
photon

## 1 What are electromagnetic waves? (continued)

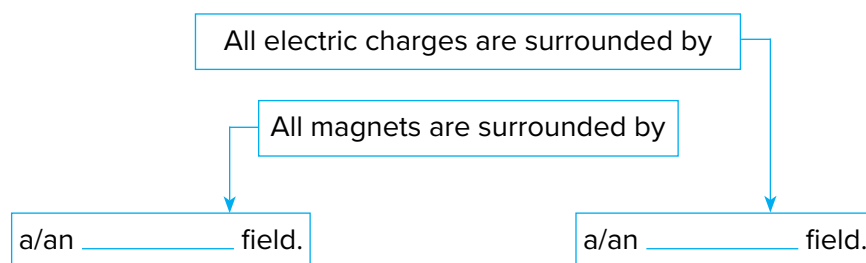
**Get It? Identify** What produces waves, and what do waves carry?

**Compare** sound and water waves with electromagnetic waves by completing the Venn diagram. Place each characteristic in the correct place in the diagram.

- carry energy from one place to another
- do not require matter to transfer energy
- must move through matter
- transfer energy between vibrating electric and magnetic fields
- transfer energy from particle to particle
- produced by vibrations



**Complete** the information about electric and magnetic fields.



## 1 What are electromagnetic waves? (continued)

**Sequence** steps as vibrating electric and magnetic fields become a wave that travels through space.

1. The changing electric field

2.

3.

**Model** an electromagnetic wave with a 1-m wavelength. Beneath this, create a second wave whose wavelength is shorter than the first one.

**Analyze** which wave above has a greater frequency.

**Get It? Describe** the relationship between the temperature of a material and the dominant wavelength the material emits.

**Get It? Identify** What determines whether sparks are ejected from a metal when light shines on it?

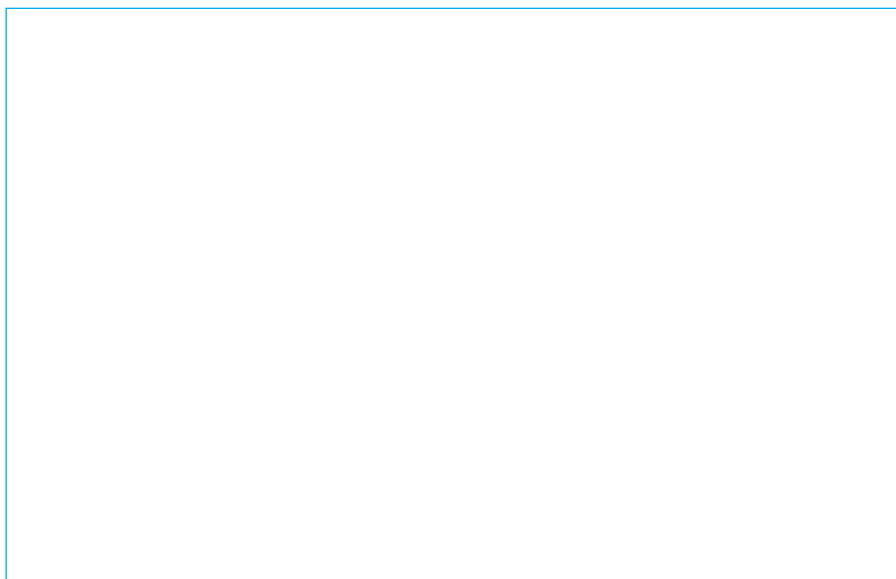
## 1 What are electromagnetic waves? (continued)

**Summarize and model** waves and particles by completing the paragraph.

All \_\_\_\_\_, not only electrons, can behave like \_\_\_\_\_.

When waves of particles pass through two slits, they will form \_\_\_\_\_.

**Create** a drawing of the pattern that forms after electrons pass through two slits.



## 1 What are electromagnetic waves? (continued)

### CHECK YOUR PROGRESS

1. **Infer** Would a vibrating proton produce an electromagnetic wave? Would a vibrating neutron? Explain.

---

---

---

2. **Compare** the frequency of an electromagnetic wave with the frequency of the vibrating charge that produces the wave.

---

3. **Describe** how electromagnetic waves transfer energy to matter.

---

---

4. **Explain** how an electromagnetic wave can travel through space that contains no matter.

---

---

---

5. **Explain** Would a stationary electron produce an electromagnetic wave? Would a stationary magnet? Explain.

---

---

---

6. **Math Connection** How many minutes does it take an electromagnetic wave to travel from the Sun to Earth (150,000,000 km)?

---

# Electromagnetic Waves

## 2 The Electromagnetic Spectrum

### REVIEW VOCABULARY

radiation

Recall the definition of the Review Vocabulary term.

*radiation*

### NEW VOCABULARY

radio wave

microwave

infrared wave

visible light

ultraviolet wave

X-ray

gamma ray

Use your book to define each term.

*radio wave*

*microwave*

*infrared wave*

*visible light*

*ultraviolet wave*

*X-ray*

*gamma ray*

## 2 The Electromagnetic Spectrum (continued)

**Organize** electromagnetic waves based on their different frequencies.

Waves with Lower Frequency Than Visible Light	Waves with Higher Frequency Than Visible Light
1.	1.
2.	2.
3.	3.

**Get It? Describe** the differences between microwaves and radio waves.

---

---

---

**Get It? Describe** the steps by which a microwave oven heats food.

---

---

---

**Get It? Compare** the effects on matter caused by the absorption of electromagnetic radiation of different wavelengths.

---

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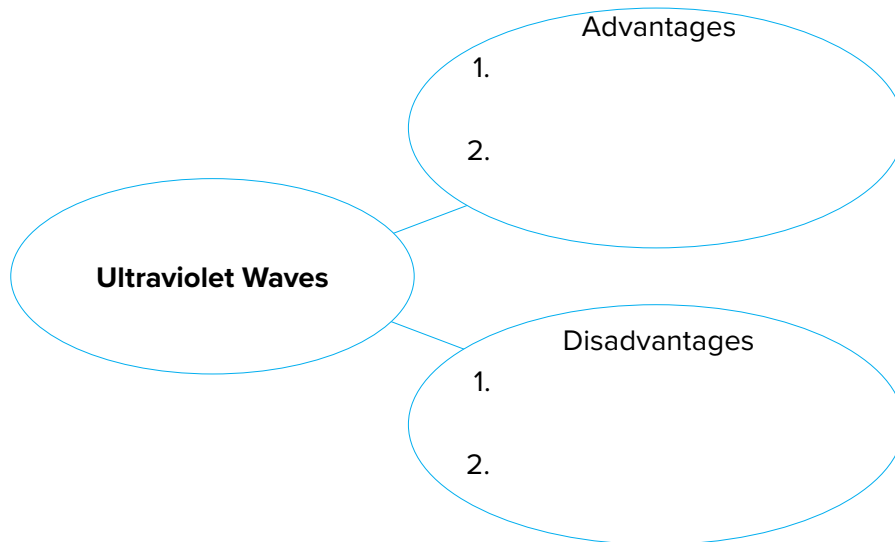


## 2 The Electromagnetic Spectrum (continued)

**Identify** the key features of some electromagnetic waves by filling in the table below.

Wave	Feature
radio	
	cause water molecules to rotate and heat up
infrared	
	short-wavelength waves that can cause sunburn

**Compare** the advantages and disadvantages to humans of ultraviolet waves by filling in the blanks in the following graphic organizer.



**Analyze** how chlorofluorocarbons affect Earth's ozone layer and why this is a concern to scientists.

---

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---

## 2 The Electromagnetic Spectrum (continued)

**Summarize** the different types of electromagnetic waves by completing the following paragraph.

Radio waves are \_\_\_\_\_. Waves that are less than 30 cm, called \_\_\_\_\_, make it possible to \_\_\_\_\_. Some \_\_\_\_\_ are used for finding the location of planes, boats, and cars by a method called \_\_\_\_\_. Some electromagnetic waves can be dangerous. \_\_\_\_\_ have very short wavelengths. Both \_\_\_\_\_ and \_\_\_\_\_ can kill \_\_\_\_\_. This is useful in treating \_\_\_\_\_, but doctors must be careful not to kill healthy cells as well. Special detectors use \_\_\_\_\_ to make images of objects based on the waves they emit. Near the \_\_\_\_\_ of the frequency range, \_\_\_\_\_ makes it possible for us to \_\_\_\_\_.

## 2 The Electromagnetic Spectrum (continued)

### CHECK YOUR PROGRESS

7. **Compare and contrast** the properties and uses of radio waves, infrared waves, and ultraviolet waves.

---

---

---

8. **Explain** A mug of tea is heated in a microwave oven. Explain why the tea gets hotter than the mug.

---

---

9. **Identify** the beneficial effects and the harmful effects of human exposure to ultraviolet waves.

---

---

10. **Name** three objects in a home that produce electromagnetic waves, and describe how the electromagnetic waves are used.

---

---

11. **Explain** How could infrared imaging be used to find a lost hiker?

---

---

12. **Math Connection** Use scientific notation to express the range of wavelengths corresponding to visible light, ultraviolet waves, and X-rays.

---

---

13. **Math Connection** A nanometer, abbreviated nm, equals one-billionth of a meter, or  $10^{-9}$  m. Express the range of wavelengths corresponding to visible light, ultraviolet waves, and X-rays in nanometers.

---

---

# Electromagnetic Waves

## 3 Radio Communication

### REVIEW VOCABULARY

amplitude

Recall the definition of the Review Vocabulary term.

amplitude

### NEW VOCABULARY

carrier wave

modulation

analog signal

digital signal

transceiver

Global Positioning System  
(GPS)

Use your book to define each term.

carrier wave

modulation

analog signal

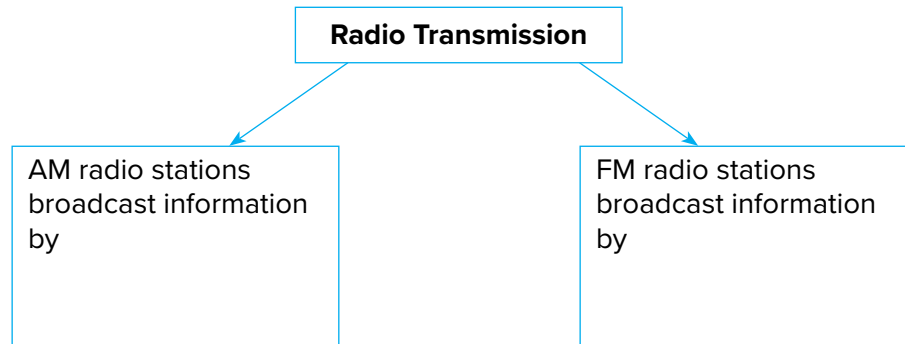
digital signal

transceiver

Global Positioning System (GPS)

### 3 Radio Communication (continued)

**Compare** AM and FM radio transmission by completing the organizer below.



**Get It?** **Compare and contrast** AM and FM radio signals.

---

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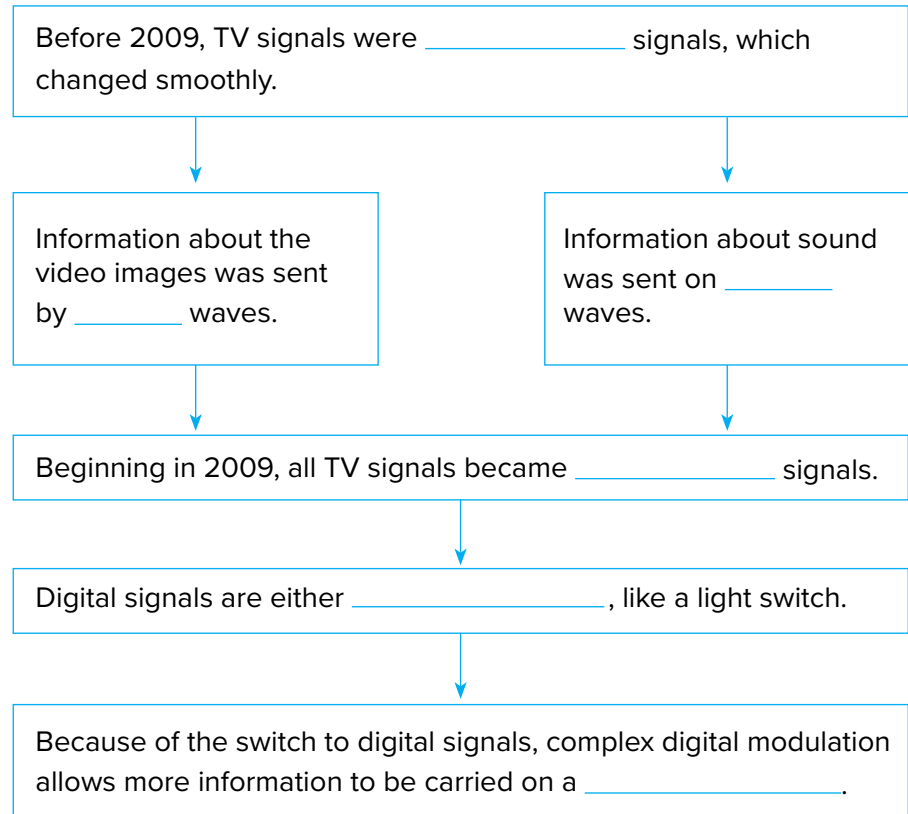
**Get It?** **Describe** how a radio signal's strength changes as you move away from the tower.

---

---

### 3 Radio Communication (continued)

**Complete** the flowchart below to describe the transmission of television signals.



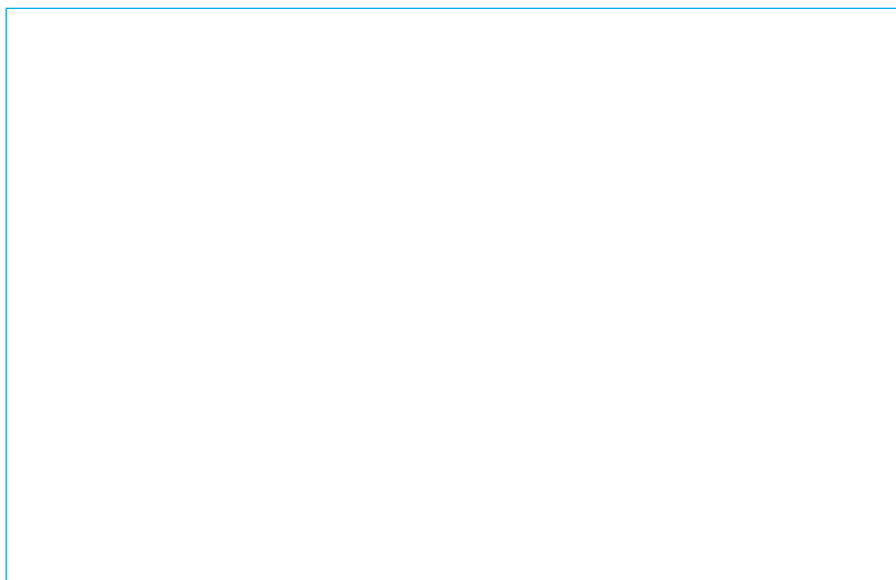
**Organize** what you have learned about telephones by completing the table below.

Type	Features	Advantage	Disadvantage
Corded	stays in one place	sends/receives consistent signal	must use in one place
		not joined to the base	
Pager			
			tower needed

### 3 Radio Communication (continued)

**Create** a sketch to show how a satellite telephone system works.

- Use arrows to show the path of the signal.
- Include the sender, a satellite, and the receiver in your sketch.



### 3 Radio Communication (continued)

#### CHECK YOUR PROGRESS

- 14. Identify and describe** the steps that a radio station uses to broadcast sounds to your radio receiver.

---

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---

- 15. Explain** the difference between AM and FM radio. Make a sketch of how a carrier wave is modulated in AM and FM radio signals.

---

---

- 16. Describe** what happens to your signal when you are talking on a cell phone and you travel from one cell to another cell.

---

---

- 17. Describe** some of the uses of the Global Positioning System. Why might emergency vehicles be equipped with GPS receivers?

---

---

- 18. Explain** Why do cordless telephones stop working when you move too far from the base unit?

---

---

- 19. Math Connection** A TV screen is composed of many points of light called pixels. A standard TV has 480 pixels horizontally and 360 pixels vertically. A high-definition TV has 1920 horizontal and 1080 vertical pixels. What is the ratio of the number of pixels in a high-definition TV to the number in a standard TV?

---



# 12 Light

## ENCOUNTER THE PHENOMENON

Write the Encounter the Phenomenon question for this module.

Use the “What I Know” column to list the things you know about the Encounter the Phenomenon question. Then list the questions you have about the Encounter the Phenomenon question in the “What I Want to Find Out” column. As you read the module, fill in the “What I Learned” column.

K <i>What I Know</i>	W <i>What I Want to Find Out</i>	L <i>What I Learned</i>

# Light

## 1 The Behavior of Light

### REVIEW VOCABULARY

visible light

Recall the definition of the Review Vocabulary term.

visible light

### NEW VOCABULARY

opaque

translucent

transparent

index of refraction

mirage

Use your book to define each term.

opaque

translucent

transparent

index of refraction

mirage

## 1 The Behavior of Light (continued)

**Summarize** each term below. Then give three examples of a material that has the same light-transmitting properties.

Opaque: \_\_\_\_\_

Examples: \_\_\_\_\_

Translucent: \_\_\_\_\_

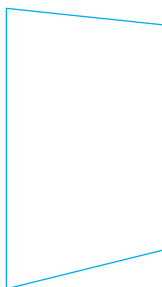
Examples: \_\_\_\_\_

Transparent: \_\_\_\_\_

Examples: \_\_\_\_\_

**Model** a light wave that hits a plane mirror at a  $25^\circ$  angle and reflects. Use a protractor to accurately draw and label the angles.

- the angle of incidence
- the angle of reflection
- the normal



**Get It? Identify** some objects that produce regular reflections and some objects that produce diffuse reflections.

---

---

---

## 1 The Behavior of Light (continued)

**Analyze** a spoon resting in a glass of water. Explain how you can tell water has a larger index of refraction than air.

---

---

---

**Get It? Identify** when refraction occurs.

---

---

**Evaluate** how a prism separates white light by completing the statements.

A triangular prism \_\_\_\_\_ light twice—once when it \_\_\_\_\_ the prism and again when it \_\_\_\_\_ the prism and reenters the \_\_\_\_\_.

\_\_\_\_\_ wavelengths of light are refracted \_\_\_\_\_ than shorter wavelengths, so \_\_\_\_\_ light is bent the least.

Because of the different amounts of \_\_\_\_\_, the different colors are \_\_\_\_\_ when they emerge from the prism.

**Get It? Predict** which color of light you would expect to bend the most.

---

**Summarize** the reflection and refraction of mirages.

---

---

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---

---

## 1 The Behavior of Light (continued)

### CHECK YOUR PROGRESS

1. **Describe** two ways that you could direct a light wave around a corner.

---

---

2. **Predict** how rubbing a mirror with sandpaper will affect how the mirror reflects light.

---

---

3. **Identify** what an object's index of refraction indicates.

---

---

4. **Explain** what happens to white light when it passes through a prism.

---

---

---

5. Decide whether the lens of your eye, your fingernails, your skin, and your tooth are opaque, translucent, or transparent. Explain.

---

---

---

6. **Math Connection** A light ray strikes a mirror at an angle of  $42^\circ$  from the surface of the mirror. What angle does the reflected ray make with the normal?

---

7. **Math Connection** A ray of light hits a mirror at  $27^\circ$  from the normal. What is the angle between the reflected ray and the normal?

---

# Light

## 2 Light and Color

### REVIEW VOCABULARY

wavelength

Recall the definition of the Review Vocabulary term.

wavelength

### NEW VOCABULARY

filter

pigment

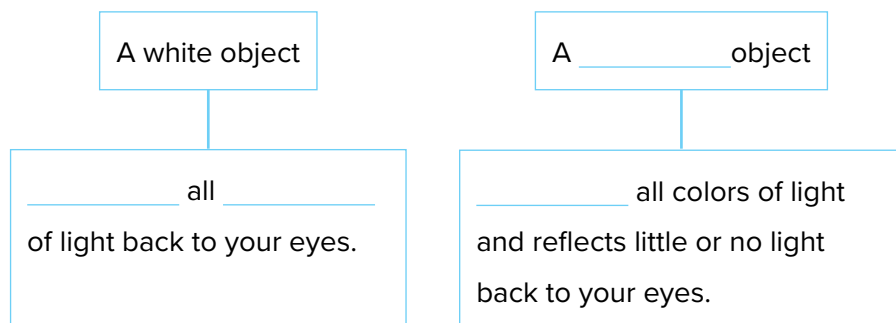
Use your book to define each term.

filter

pigment

## 2 Light and Color (continued)

**Complete** the graphic organizer about black and white color reflection.



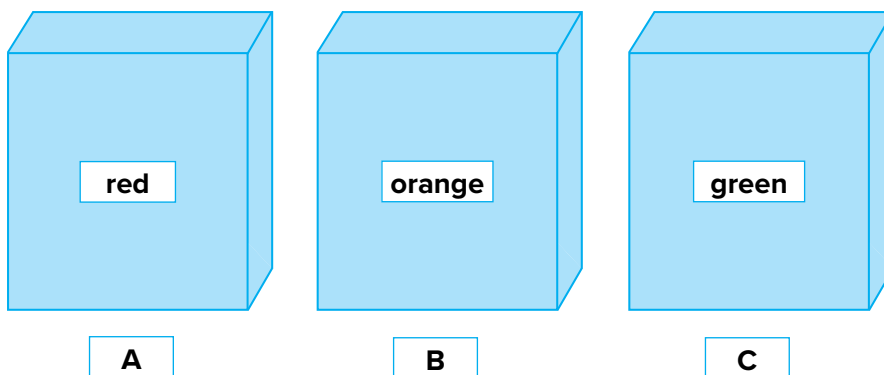
**Get It? Explain** why a white object is white.

---



---

**Model** Figures A, B, and C represent children's building blocks. Fill in the table below to show how each block reflects and absorbs light. Part of the table has been filled in for you.



Color(s)	Block A	Block B	Block C
Reflected			
Absorbed	orange, yellow, green, blue, indigo, violet		

## 2 Light and Color (continued)

**Get It? Identify** the colors of light detected by each type of cone cell.

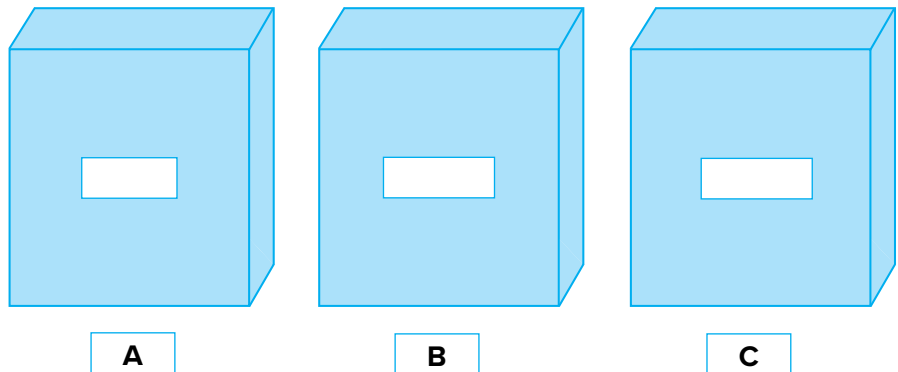
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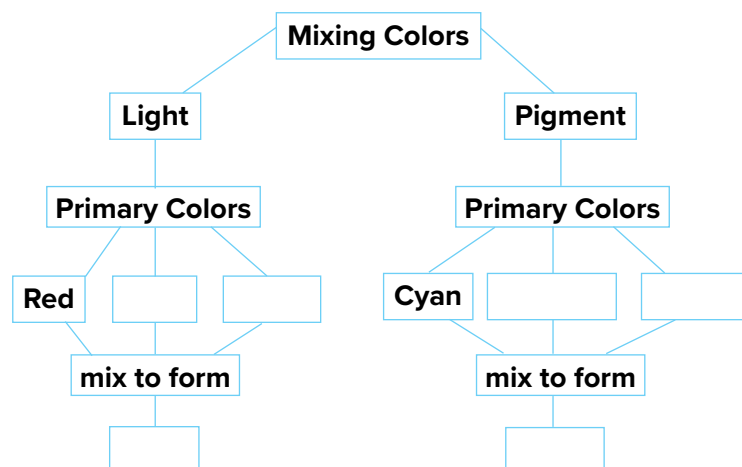
**Complete** the following information about filters.

A filter is a \_\_\_\_\_ material that transmits \_\_\_\_\_  
\_\_\_\_\_ but \_\_\_\_\_ all others. The name of the color of a \_\_\_\_\_  
is the color of the \_\_\_\_\_ that it \_\_\_\_\_.

**Distinguish** between the colors that blocks A (red), B (orange), and C (green) would look through a red filter. Label each block according to the color that it would appear.



**Organize** information about how colors mix.





## 2 Light and Color (continued)

### CHECK YOUR PROGRESS

8. **Explain** why a white fence appears to be white. In your answer, include the colors of light that your eye detects, and tell how your brain interprets those colors.

---

---

9. **Identify** what color would be seen if equal amounts of red light and green light were mixed.

---

10. **Compare and contrast** the primary colors of light and the primary pigment colors.

---

---

---

---

11. **Describe** how your eyes detect color.

---

---

---

12. **Predict** Light reflected from an object passes through a green filter, then a red filter, and finally a blue filter. What color will the object appear to be?

---

13. **Math Connection** In the human eye, there are about 120,000,000 rods. If 90,000,000 rods trigger at once, what percent of the total number of rods are triggered?

---

14. **Math Connection** The wavelengths of a color are measured in nanometers (nm), which is 0.000000001 meters (one-billionth of a meter). Find the wavelength in meters of a light wave that has a wavelength of 690 nm.

---

# Light

## 3 Producing Light

### REVIEW VOCABULARY

thermal energy

Recall the definition of the Review Vocabulary term.

thermal energy

### NEW VOCABULARY

incandescent light

fluorescent light

coherent light

incoherent light

Use your book to define each term.

incandescent light

fluorescent light

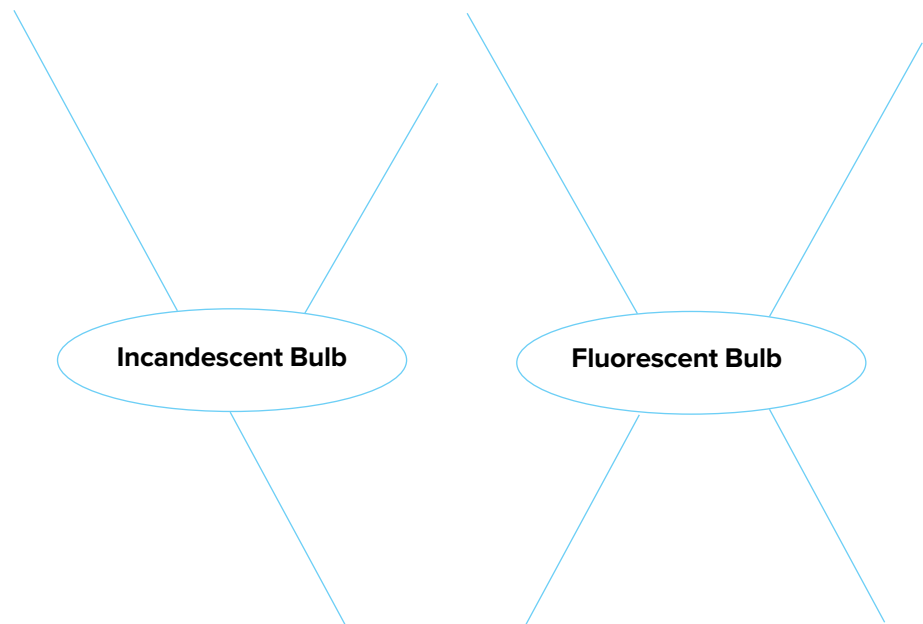
coherent light

incoherent light

### 3 Producing Light (continued)

**Distinguish** between an incandescent bulb and a fluorescent bulb by placing the following characteristics with the correct type of bulb in the concept map.

- contains a filament
- gives off about 90 percent of its energy as heat
- contains electrodes at each end
- uses less energy to produce the same amount of light
- emits ultraviolet radiation
- filled with a gas
- generates light by heating a piece of metal until it glows



**Compare and contrast** fluorescent lights with neon lights.

Similarity: \_\_\_\_\_

Difference: \_\_\_\_\_

\_\_\_\_\_

**Get It? Identify** what causes the color in a neon light.

\_\_\_\_\_

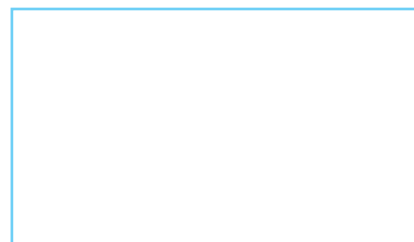
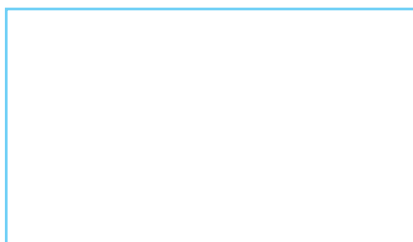
\_\_\_\_\_

### 3 Producing Light (continued)

**Classify** which type of light is being described below.

Type of Lighting	Description
	very bright light, long-lasting bulbs
	focuses light on small areas, used to send information in pulses
	outdoor lighting with a yellow-orange glow

**Model** coherent and incoherent light waves with side-by-side sketches.



**Evaluate** uses of coherent and incoherent light and explain the suitability of each type of light to its purpose.

---

---

---

**Analyze** three reasons lasers are useful to surgeons.

1. 

---
2. 

---
3. 

---

### 3 Producing Light (continued)

#### CHECK YOUR PROGRESS

- 15. Compare and contrast** the two main types of bulbs found in your home. Explain how they produce light.

---

---

- 16. Discuss** the advantages of using a fluorescent bulb instead of an incandescent bulb.

---

- 17. Describe** the difference between coherent and incoherent light.

---

---

---

- 18. Describe** the processes used to produce light in a laser.

---

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---

- 19. Identify** several uses of lasers.

---

- 20. Apply** Which type of lighting device would you use for each of the following needs: an economical light source in a manufacturing plant, an eye-catching sign that will be visible at night, and a baseball stadium? Explain.

---

---

- 21. Math Connection** A 25-W fluorescent light emits 5.0 J of thermal energy each second. What is the efficiency of the fluorescent light?

---

- 22. Math Connection** If 90 percent of the energy emitted by incandescent bulbs is thermal energy, how much thermal energy is emitted by a 60-W bulb each second?

---

# Light

## 4 Using Light

### REVIEW VOCABULARY

interference

Recall the definition of the Review Vocabulary term.

interference

### NEW VOCABULARY

linearly polarized light

holography

total internal reflection

optical scanner

Use your book to define each term.

linearly polarized light

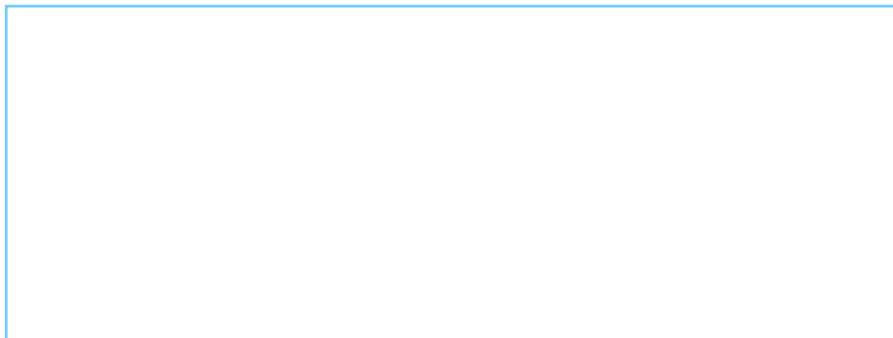
holography

total internal reflection

optical scanner

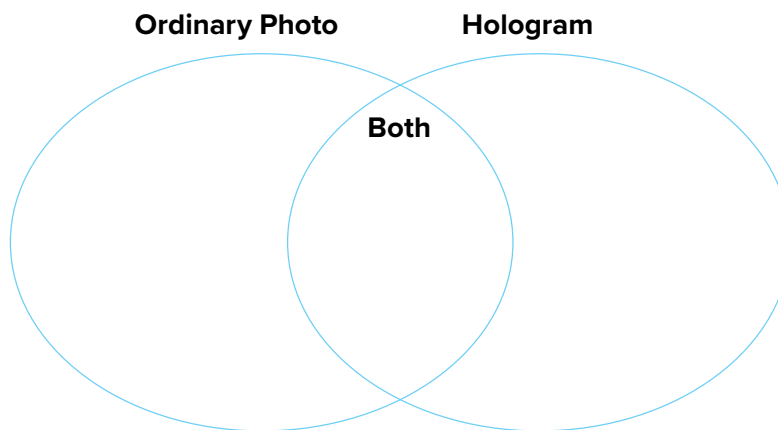
## 4 Using Light (continued)

**Create** a diagram that shows how polarized glass filters light. Be sure to include both vertically polarized and horizontally polarized light.



**Compare** a hologram with an ordinary photo by placing the following characteristics in the correct place in the Venn diagram.

- easily copied
- not easily copied
- produces flat image
- produces realistic image
- records brightness of light
- records direction of light
- three dimensional
- two dimensional
- uses laser light
- uses visible light



**Get It? Describe** how holographic images are produced.

---

---

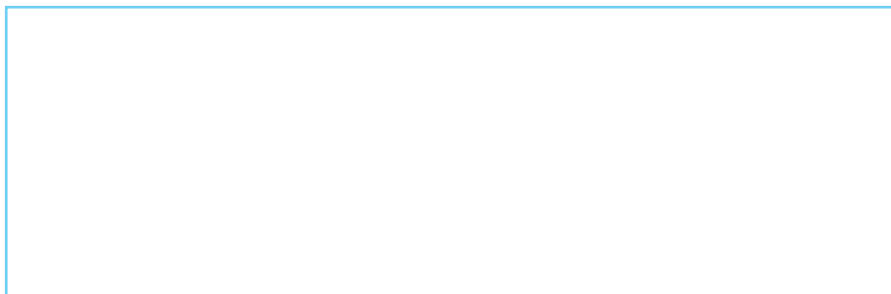
---

---

---

## 4 Using Light (continued)

**Model** how light travels between mediums, then how internal reflection happens if the light is at more than the critical angle. Use the information and figure in your book to help you.



**Get It? Identify** when total internal reflection occurs.

---

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---

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---

**Analyze** the steps in using total internal reflection to transmit light along an optical fiber.

1.

---

2.

---

3.

---

**Summarize** how an optical scanner works.

---

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---

---



## 4 Using Light (continued)

### CHECK YOUR PROGRESS

**23. Discuss** how optical fibers are used to transmit telephone conversations.

---

---

---

**24. Contrast** polarized and unpolarized light.

---

---

**25. Describe** how a hologram is made.

---

---

---

**26. Identify** all the conditions that are necessary for total internal reflection to occur.

---

---

**27. Investigate** On a sunny day, you are looking at the surface of a lake through polarized sunglasses. How could you use your sunglasses to tell if the light reflected from the lake is polarized?

---

---

**28. Math Connection** An optical fiber has a diameter of 0.3 mm. How many fibers would be needed to form a cable with a square cross section if the cross section was 1.5 cm on a side?

---



# 13 Mirrors and Lenses

## ENCOUNTER THE PHENOMENON

Write the Encounter the Phenomenon question for this module.

---

---

---

Use the “What I Know” column to list the things you know about the Encounter the Phenomenon question. Then list the questions you have about the Encounter the Phenomenon question in the “What I Want to Find Out” column. As you read the module, fill in the “What I Learned” column.

K <i>What I Know</i>	W <i>What I Want to Find Out</i>	L <i>What I Learned</i>

# Mirrors and Lenses

## 1 Mirrors

### REVIEW VOCABULARY

reflection

### NEW VOCABULARY

plane mirror

virtual image

concave mirror

optical axis

focal point

focal length

real image

convex mirror

Recall the definition of the Review Vocabulary term.

reflection

Use your book to define each term.

plane mirror

virtual image

concave mirror

optical axis

focal point

focal length

real image

convex mirror

## 1 Mirrors (continued)

**Get It? Identify** two ways to imagine light coming from a source.

---

---

**Get It? Define** What is a plane mirror?

---

**Get It? Describe** the steps that allow you to see your face in a plane mirror.

---

---

---

## 1 Mirrors (continued)

**Sequence** the steps in the path that light rays take when a girl sees her image in a plane mirror. The steps are written in scrambled order on the right. Rewrite them in the correct order in the boxes. Use the figure in your book to help you.

The light source puts out rays of light.



Some of the reflected light rays hit the mirror.

The girl sees her image in the mirror.

The light source puts out rays of light.

Some of the reflected light rays hit the girl's eyes.

The light rays reflect off of the mirror in all directions.

The light rays reflect off of the girl in all directions.

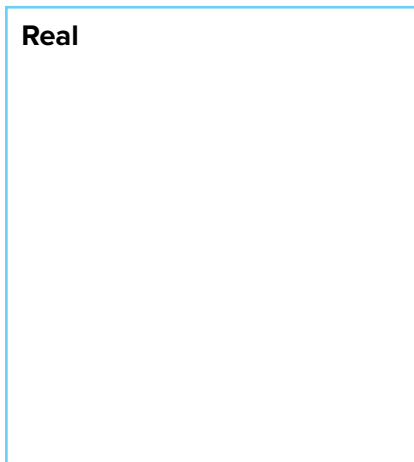
Some of the light rays strike the girl.

**Get It? Explain** Why does your reflected image in a plane mirror appear to be behind the mirror?

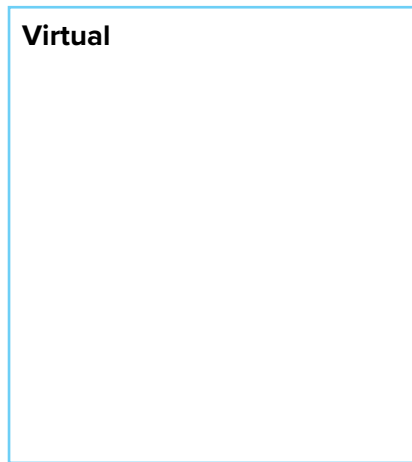
## 1 Mirrors (continued)

**Distinguish** between a real and a virtual image. If it helps you to explain, draw a sketch below your sentences.

**Real**



**Virtual**



**Get It? Describe** the relationship between the focal point and the focal length for a concave mirror.

---

---

**Predict** the distance between an object and a concave mirror for each resulting image. Each distance should be a number relative to the mirror's focal length.

- a bright beam of light
- real, upside down, and larger than object
- virtual, upright, and larger than object
- real, upside down, and smaller than object

---

---

---

---

**Get It? Describe** the image formed by a convex mirror.

---

---

## 1 Mirrors (continued)

**Analyze** why the image formed by a convex mirror is always virtual.

---

---

---

---

---

**Get It? Evaluate** What are the benefits and drawbacks of using convex mirrors on automobiles instead of plane mirrors?

---

---

---

**Get It? Identify** which mirrors form only virtual images.

---

---

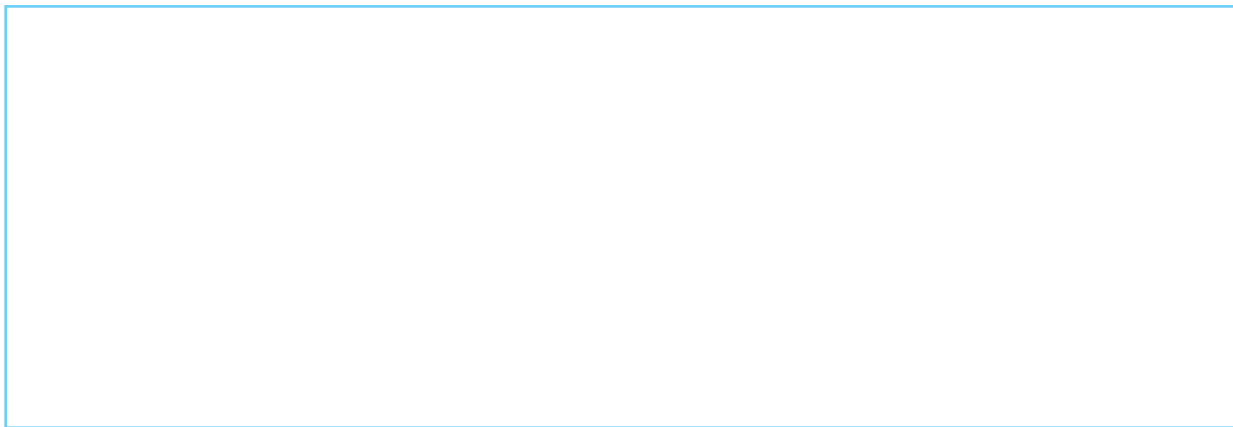
---



## 1 Mirrors (continued)

### CHECK YOUR PROGRESS

1. **Diagram** how both concave mirrors and convex mirrors form images.



2. **Identify** at least one example of a plane mirror, one example of a concave mirror, and one example of a convex mirror.

---

---

---

3. **Describe** the image of an object that is 38 cm from a concave mirror that has a focal length of 10 cm.

---

---

4. **Infer** whether a virtual image can be photographed.

---

---

5. **Describe** An object is less than one focal length from a concave mirror. How does the size of the image change as the object gets closer to the mirror?

---

6. **Math Connection** If you stand 2 m away from a plane mirror, how far away does your reflection appear to be from you?

---

# Mirrors and Lenses

## 2 Lenses

### REVIEW VOCABULARY

transparent

Recall the definition of the Review Vocabulary term.

transparent

### NEW VOCABULARY

convex lens

concave lens

cornea

retina

Use your book to define each term.

convex lens

concave lens

cornea

retina

## 2 Lenses (continued)

**Define** the term *lens*. Draw an example.

---



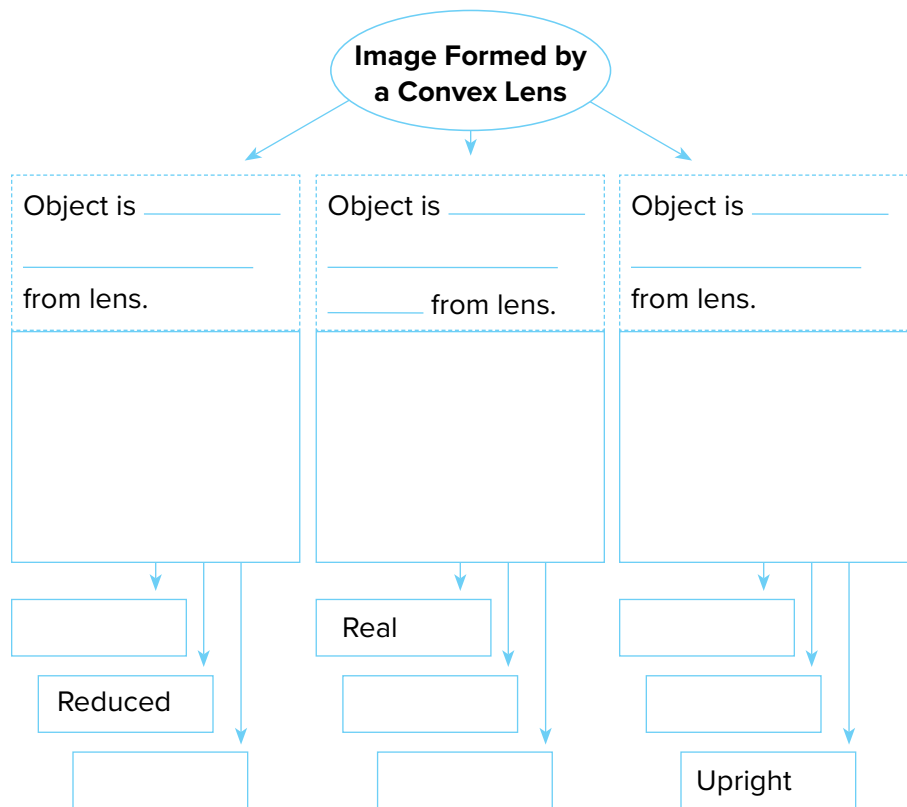
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---

**Complete** the concept map about convex lenses. Use the figures in your book to help you. Fill in the map using the following hints.

1. At what distance should the object be from the lens?
2. Draw a sketch of the object, lens, and image.
3. Is the image real or virtual?
4. Is the image reduced or enlarged?
5. Is the image upright or inverted (upside down)?



**Predict** what will happen to the image produced by a concave lens as the lens gets flatter and flatter—more like a flat piece of glass.

---



---



---

## 2 Lenses (continued)

**Get It? Describe** the function of the cornea.

---

---

**Get It? Describe** the function of the retina.

---

---

**Sequence** the steps that occur in human vision after light enters the eye through the cornea. Unscramble the steps and write them in the correct order in the boxes.

1. The cornea bends light rays to bring them together.

2.

3.

4.

5.

6.

- The light goes through the pupil.
- The optic nerve sends electrical signals to the brain.
- The lens behind the pupil brings light rays together.
- The light rays form an image on the retina.
- The cornea bends light rays to bring them together.
- The retina changes the image into electrical signals.

**Get It? Describe** how the shape of the lens in your eye changes when you focus on a nearby object.

---

---

## 2 Lenses (continued)

**Organize** information on common vision problems.

<b>Problem</b>	<b>Vision Good For</b>	<b>Cause</b>	<b>Image Location</b>	<b>Eyeglass Lens Shape</b>
Nearsighted				
Farsighted				
Astigmatism				

## 2 Lenses (continued)

### CHECK YOUR PROGRESS

7. **Sketch** light rays as they pass through a convex lens and then through a concave lens.

8. **Compare** the image of an object less than one focal length from a convex lens with the image of an object more than two focal lengths from the lens.

---

---

---

9. **Describe** the image formed by a concave lens.

---

10. **Explain** how lenses are used to correct vision problems.

---

---

11. **Describe** If image formation by a convex lens is similar to that by a concave mirror, describe the image formed by a light source placed at the focal point of a convex lens.

---

---

---

12. **Math Connection** If you looked through a convex lens with a focal length of 15 cm and saw a real, upside down, enlarged image, what is the maximum distance between the lens and the object?

---

---

---

# Mirrors and Lenses

## 3 Optical Instruments

### REVIEW VOCABULARY

refraction

Recall the definition of the Review Vocabulary term.

refraction

### NEW VOCABULARY

refracting telescope

reflecting telescope

microscope

Use your book to define each term.

refracting telescope

reflecting telescope

microscope

### 3 Optical Instruments (continued)

**Evaluate** a telescope design that magnifies objects but does not gather more light than the naked eye.

**Summarize** challenges to building a large refracting telescope to be used on Earth.

1. \_\_\_\_\_
2. \_\_\_\_\_
3. \_\_\_\_\_
4. \_\_\_\_\_

**Sequence** the steps that occur in a reflecting telescope after light enters one end of the telescope. The steps are written in scrambled order at right. Write them in the correct order in the boxes.

	The light rays start to come together.
↓	
	The convex lens in the eyepiece magnifies the image.
↓	
	A real image of the object forms.
↓	
The plane mirror reflects the light toward the eyepiece.	The light rays hit a plane mirror.
↓	
	The light reflects off of a concave mirror at the other end.
↓	
	The plane mirror reflects the light toward the eyepiece.



### 3 Optical Instruments (continued)

**Get It? Identify** the interactions of waves and matter that allow reflecting telescopes to function.

---

---

**Get It? Explain** why a space telescope is able to produce clearer images than telescopes on Earth.

---

---

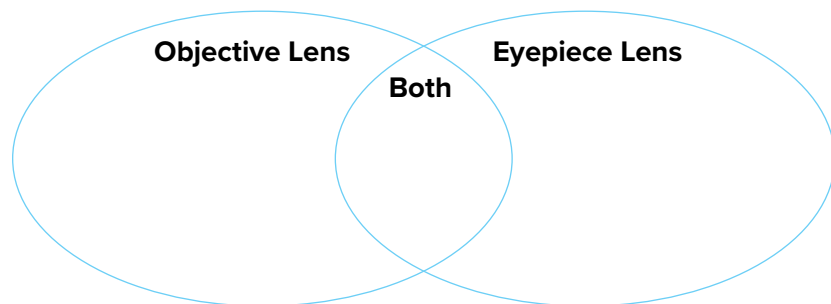
**Get It? Compare** the image formed by the objective lens of a microscope with the image formed by the eyepiece lens.

---

---

**Compare** the objective lens and the eyepiece lens of a simple microscope by completing the Venn diagram with the phrases in the bank.

- |  |   |
|--|---|
| • Convex lens  | • Real image  |
| • Enlarged image   | • Virtual image   |
| • Distance from object to lens is less than one focal length | • Distance from object to lens is between one and two focal lengths |



### 3 Optical Instruments (continued)

**Compare** the parts of a camera with the parts of an eye that serve the same function by completing each sentence.

The shutter of a camera is like the \_\_\_\_\_ of an eye because they

---

The lens of a camera is like the \_\_\_\_\_ of an eye because they

---

The image sensor is like the \_\_\_\_\_ of an eye because they

---

### 3 Optical Instruments (continued)

#### CHECK YOUR PROGRESS

**13. Identify** the advantage to making the objective lens larger in a refracting telescope.

---

---

**14. Describe** the image formed by the objective lens in a microscope.

---

**15. Explain** why the largest telescopes are reflecting telescopes instead of refracting telescopes.

---

---

---

**16. Explain** which optical instrument—a telescope, a microscope, or a camera—forms images in a way most like your eye.

---

---

---

**17. Math Connection** Suppose the objective lens in a microscope forms an image that is 100 times the size of an object. The eyepiece lens magnifies this image 10 times. What is the total magnification?

---



# 14 Solids, Liquids, and Gases

## ENCOUNTER THE PHENOMENON

Write the Encounter the Phenomenon question for this module.

---

---

---

Use the “What I Know” column to list the things you know about the Encounter the Phenomenon question. Then list the questions you have about the Encounter the Phenomenon question in the “What I Want to Find Out” column. As you read the module, fill in the “What I Learned” column.

K <i>What I Know</i>	W <i>What I Want to Find Out</i>	L <i>What I Learned</i>

# Solids, Liquids, and Gases

## 1 Matter and Thermal Energy

### REVIEW VOCABULARY

kinetic energy

Recall the definition of the Review Vocabulary term.

kinetic energy

### NEW VOCABULARY

kinetic theory

melting point

heat of fusion

boiling point

heat of vaporization

sublimation

plasma

thermal expansion

Use your book to define each term.

kinetic theory

melting point

heat of fusion

boiling point

heat of vaporization

sublimation

plasma

thermal expansion

## 1 Matter and Thermal Energy (continued)

**Complete** the outline as you read about the states of matter.

### States of Matter

#### A. Solid

1. Example: \_\_\_\_\_
2. Particle kinetic energy: \_\_\_\_\_
3. Particle behavior: \_\_\_\_\_
4. Other fact(s): \_\_\_\_\_

#### B. Liquid

1. Example: \_\_\_\_\_
2. Particle kinetic energy: \_\_\_\_\_
3. Particle behavior: \_\_\_\_\_
4. Other fact(s): \_\_\_\_\_

#### C. Gas

1. Example: \_\_\_\_\_
2. Particle kinetic energy: \_\_\_\_\_
3. Particle behavior: \_\_\_\_\_
4. Other fact(s): \_\_\_\_\_

#### D. Plasma

1. Example: \_\_\_\_\_
2. Particle kinetic energy: \_\_\_\_\_
3. Particle behavior: \_\_\_\_\_
4. Other fact(s): \_\_\_\_\_

**Sequence** the kinetic energy, temperature, and density of most solids, liquids, and gases. Use 1 to represent the lowest amount and 3 to represent the highest.

	Solid	Liquid	Gas
Kinetic energy			
Temperature			
Density			

## 1 Matter and Thermal Energy (continued)

**Compare** the density of water's solid state to that of other solid materials.

---

---

---

---

**Explain** why the line on a heating curve is flat at the melting point and boiling point.

---

---

---

---

---

**Organize** the features and examples of other states of matter in the following table.

	Amorphous Solid	Liquid Crystal
Liquid		
Solid		
Examples		

**Get It? Describe** how forces between and within water molecules cause ice to float.

---

---

---



## 1 Matter and Thermal Energy (continued)

### CHECK YOUR PROGRESS

1. **Describe** the movement of the particles in solids, liquids, and gases.

---

2. **State** the basic assumptions of the kinetic theory.

---

---

3. **Describe**, in terms of kinetic theory, how the particles of a substance behave at its melting point.

---

4. **Describe**, in terms of kinetic theory, how the particles of a substance behave at its boiling point.

---

5. **Infer** How would the heating curve for glass be different from the heating curve for water?

---

---

6. **Math Connection** Using the graph in **Figure 7**, describe the energy changes that are occurring when water goes from  $-15^{\circ}\text{C}$  to  $120^{\circ}\text{C}$ .

---

---

---

7. **Math Connection** The melting point of acetic acid is  $17^{\circ}\text{C}$ , and the boiling point is  $118^{\circ}\text{C}$ . Draw a graph similar to the graph in **Figure 7** showing the phase changes for acetic acid. Clearly mark the three phases, the boiling point, and the melting point on the graph.

# Solids, Liquids, and Gases

## 2 Properties of Fluids

### REVIEW VOCABULARY

density

Recall the definition of the Review Vocabulary term.

density

### NEW VOCABULARY

buoyancy

pressure

viscosity

Use your book to define each term.

buoyancy

pressure

viscosity

## 2 Properties of Fluids (continued)

**Get It?** **Infer** why rocks sink and rubber balls float in water.

---

---

---

---

---

**Evaluate** the buoyant force on a block of iron and on a block of plastic foam. Each block has the same volume. Make sketches that show the forces acting on each block and whether each block sinks or floats.

--	--

**Get It?** **Explain** why a steel block sinks but a steel ship floats.

---

---

---

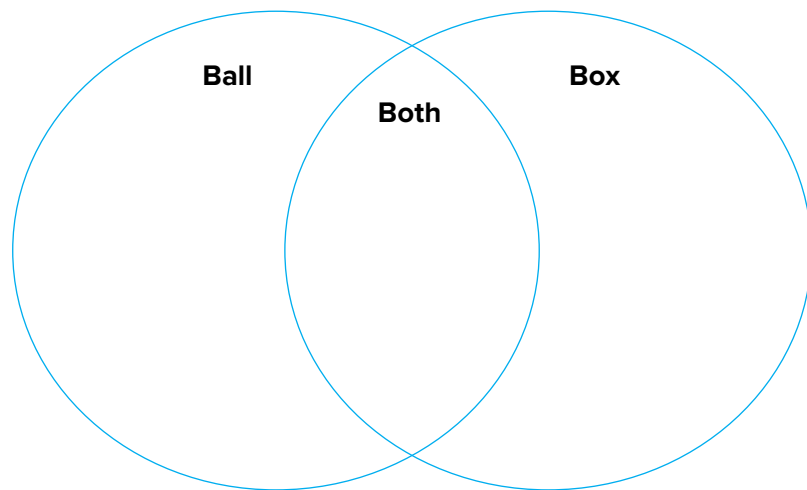
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## 2 Properties of Fluids (continued)

**Organize** the physical properties of two identical pieces of foil formed into different shapes. One piece of foil is crumpled tightly into a ball. The other is folded into a box that is open on top. What happens when both pieces are dropped into a container of water? Use the terms below to complete the Venn diagram.

- floats
- mass
- foil and air displace water
- more volume displaced
- higher density
- only foil displaces water
- less volume displaced
- sinks
- lower density
- weight



**Summarize** Pascal's principle in your own words. Include two examples of objects that work because of Pascal's principle, other than those given in your book.

---

---

Examples:

1. 

---

2. 

---

## 2 Properties of Fluids (continued)

**Get It? Describe** how the pressure changes as the velocity of a fluid increases.

---

**Explain** how Bernoulli's principle makes the hose-end sprayer operate.

---

---

---

---

---

**Analyze** the relationship between viscosity and temperature that is suggested by the saying "as slow as molasses in January".

---

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---

---

---

**Infer** Use Bernoulli's principle to explain how a hurricane wind might lift a roof from a house.

---

---

---

## 2 Properties of Fluids (continued)

### CHECK YOUR PROGRESS

13. **Describe** how fluids exert forces on objects.

---

---

14. **Explain** why a steel boat floats on water but a steel block does not.

---

---

15. **Explain** why squeezing a plastic mustard bottle forces mustard out the top.

---

---

16. **Describe**, using Bernoulli's principle, how roofs are lifted off buildings in tornados.

---

---

17. **Infer** If you blow up a balloon, tie it off, and release it, it will fall to the floor. Why does it fall instead of float? Explain what would happen if the balloon contained helium instead of air.

---

---

18. **Math Connection** The density of water is  $1.0 \text{ g/cm}^3$ . How many kilograms of water does a submerged  $120\text{-cm}^3$  block displace. Recall that  $1.0 \text{ kg}$  weighs  $9.8 \text{ N}$  on Earth. What is the buoyant force on the block?

---

---

19. **Math Connection** To lift an object weight  $21,000 \text{ N}$ , how much force is needed on a piston with an area of  $0.060 \text{ m}^2$  if the platform being lifted has an area of  $3.0 \text{ m}^2$ ?

---

---

# Solids, Liquids, and Gases

## 3 Behavior of Gases

### REVIEW VOCABULARY

temperature

Recall the definition of the Review Vocabulary term.

temperature

### NEW VOCABULARY

Boyle's law

Charles's law

Use your book to define each term.

Boyle's law

Charles's law

### 3 Behavior of Gases (continued)

**Get It? Describe** what happens to weather balloons as they rise.

---

---

**Compare** the different pressures that result as you add air to a balloon and as you add air to a steel tank.

---

---

---

---

---

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---

---

**Get It? Explain** the relationship between pressure and volume.

---

---

**Get It? Show** how to write the Boyle's law equation when it is solved for the final pressure of a gas.

---



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Low Temperature	High Temperature

	Charles's Law	Boyle's Law
Constant Property		
Varying Properties		
Type of Variance		
Formula		

### 3 Behavior of Gases (continued)

#### CHECK YOUR PROGRESS

- 24. Describe** what would happen to the volume of a gas if the pressure on it were decreased and then the gas's temperature were increased.

---

---

---

- 25. Predict**, using Boyle's law, what will happen to a balloon that an ocean diver takes to a pressure of 202 kPa.

---

---

---

- 26. Predict** what would happen to the volume of a gas if the pressure on that gas were doubled and then the absolute temperature of the gas were doubled.

---

---

---

---

- 27. Math Connection** A helium balloon has a volume of 2.00 L at 101 kPa. As the balloon rises the pressure drops to 97.0 kPa. What is the new volume?

---

---

- 28. Math Connection** If a 5-L balloon at 25°C were gently heated to 30°C, what new volume would the balloon have?

---

# 15 Classification of Matter

## ENCOUNTER THE PHENOMENON

Write the Encounter the Phenomenon question for this module.

---

---

---

Use the “What I Know” column to list the things you know about the Encounter the Phenomenon question. Then list the questions you have about the Encounter the Phenomenon question in the “What I Want to Find Out” column. As you read the module, fill in the “What I Learned” column.

K <i>What I Know</i>	W <i>What I Want to Find Out</i>	L <i>What I Learned</i>

# Classification of Matter

## 1 Composition of Matter

### REVIEW VOCABULARY

property (of a substance or material)

### VOCABULARY

substance

element

compound

heterogeneous mixture

suspension

colloid

Tyndall effect

homogeneous mixture

solution

Recall the definition of the Review Vocabulary term.

---

---

Use the terms on the left to fill in the blanks in the sentences.

A \_\_\_\_\_ is an \_\_\_\_\_ if all the atoms in the substance are the same.

A \_\_\_\_\_ is a substance in which two or more elements are combined in a fixed proportion.

A \_\_\_\_\_ contains two or more substances blended evenly throughout.

A \_\_\_\_\_ is a mixture in which different materials remain distinct.

A \_\_\_\_\_ is another term for a homogeneous mixture. It has particles too small to see with a microscope.

The \_\_\_\_\_ is observed when light passes through a \_\_\_\_\_, which is a heterogeneous mixture with particles visible under a microscope but not heavy enough to settle.

A \_\_\_\_\_ is a heterogeneous mixture containing a liquid in which you can see particles settle.

## 1 Composition of Matter (continued)

**Classify** each substance as an element or a compound.

calcium	chalk	hydrogen	salt	water
carbon	chlorine	mercury	sodium	zinc
carbon dioxide	copper	oxygen	sugar	

Elements	Compounds

**Get It? Compare** How are elements and compounds related?

---

---

---

**Organize** information about mixtures in the outline below.

### I. Mixtures

#### A. Heterogeneous mixtures

- 
- 
- 
- Examples:

#### B. Homogeneous mixtures

- 
- 
- 
- Examples:

## 1 Composition of Matter (continued)

### C. Colloids

1. \_\_\_\_\_
2. \_\_\_\_\_
3. \_\_\_\_\_
4. Examples: \_\_\_\_\_

**Compare and contrast** colloids, solutions, and suspensions. Write the characteristics of each in the table.

	colloids	solutions	suspensions
particles			
appearance			

**Classify** each substance as a solution, a colloid, or a suspension. Write each name in one of the boxes below.

herbed salad dressing	paint	pulpy orange juice	tea
milk	perfume	smoke	vinegar

<b>colloids</b>	<b>suspensions</b>	<b>solutions</b>

## 1 Composition of Matter (continued)

### CHECK YOUR PROGRESS

1. **Distinguish** a substance from a mixture. Give two examples of each.

---

---

---

---

---

2. **Compare and Contrast** How is a compound similar to a homogeneous mixture?  
How is it different?

---

---

---

---

---

3. **Identify** three elements and three compounds. How are they similar? How are they different?

---

---

---

## 1 Composition of Matter (continued)

### CHECK YOUR PROGRESS

- 4. Summarize** Make a table that compares the properties of suspensions, colloids, and solutions.

- 5. Infer** Why do the words “Shake well before using” indicate that the fruit juice in a carton is a suspension? Why are these words not used on a milk container?

---

---

- 6. Math Connection** The weather report this morning stated there is a thick fog in your town. Visibility is less than 500 feet. How many kilometers in front of your vehicle can you see?

---

---



# Classification of Matter

## 2 Properties of Matter

### REVIEW VOCABULARY

boiling point

Recall the definition of the Review Vocabulary term.

---

---

### VOCABULARY

Read the definitions below, then write the key term for each one in the left column.

---

a characteristic that can be observed without changing the substance

---

a change in size, shape, or state of matter

---

a change of a substance or substances into another substance or other substances

---

a characteristic that indicates whether a substance can change to another substance

---

the separation of substances in a mixture using evaporation

---

the mass of all substances before a chemical change equals the mass of all substances after the change

## 2 Properties of Matter (continued)

**Distinguish** between the materials listed below. Identify a unique physical property for each one that does not describe the other materials in this group.

Material	Unique physical property
rubber	
applesauce	
marble	
copper	

**Describe** how freezing could be used to remove sugar from a mixture of sugar and water.

---

---

---

---

**Get It? Describe** how you could use physical properties to separate sand from sugar.

---

---

---

**Get It? Infer** Does a change in state mean that a new substance has formed? Explain.

---

**Get It? Explain** why the density of an unknown substance in a mixture can be used to identify the substance.

---

---

## 2 Properties of Matter (continued)

**Identify** four properties of a substance that can be used to identify the substance.

\_\_\_\_\_ , \_\_\_\_\_ , \_\_\_\_\_ , \_\_\_\_\_

**Get It? Define** What is a chemical change?

**Organize** five kinds of physical changes and five kinds of chemical changes.

Physical Changes	Chemical Changes

**Identify** chemical and physical changes that occur as a car ages.

Physical Changes	Chemical Changes

## 2 Properties of Matter (continued)

**Get It? Determine** Is weathering a physical change or a chemical change?

---

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---

**Describe** how the law of conservation of mass could be useful for investigating chemical changes.

---

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---

**Describe** some ways that industry and agriculture use physical properties to separate substances.

---

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---

## 2 Properties of Matter (continued)

### CHECK YOUR PROGRESS

9. **Explain** why evaporation of water is a physical change and not a chemical change.

---

---

10. **Identify** four physical properties that describe a liquid. Identify a chemical property.

---

---

11. **Explain** how the law of conservation of mass applies to chemical changes.

---

---

12. **Determine** Does the law of conservation of mass apply to physical changes? How could you test this for melting ice? For the distillation of water?

---

---

---

13. **Math Connection** Bismuth and fluorine react to form bismuth fluoride. If 417.96 g of bismuth reacts completely with 113.99 g of fluorine, how many grams of bismuth fluoride are formed?

---

---



# 16 Properties of Atoms and the Periodic Table

## ENCOUNTER THE PHENOMENON

Write the Encounter the Phenomenon question for this module.

---

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---

Use the “What I Know” column to list the things you know about the Encounter the Phenomenon question. Then list the questions you have about the Encounter the Phenomenon question in the “What I Want to Find Out” column. As you read the module, fill in the “What I Learned” column.

K <i>What I Know</i>	W <i>What I Want to Find Out</i>	L <i>What I Learned</i>

# Properties of Atoms and the Periodic Table

## 1 Structure of the Atom

### REVIEW VOCABULARY

element

Recall the definition of the Review Vocabulary term.

element

### NEW VOCABULARY

atom

nucleus

proton

neutron

electron

quark

electron cloud

Use your book to define each term.

atom

nucleus

proton

neutron

electron

quark

electron cloud



## 1 Structure of the Atom (continued)

**Identify** some of the elements and their symbols by filling in the table. Reference a periodic table to help you.

Symbol	Name
Pt	
	tungsten
Rn	
	iodine
B	
	lithium
Cu	
	cesium
Ni	
	lead
Es	
	helium

**Get It?** **Identify** the three types of subatomic particles.

---

---

---

**Draw** a diagram showing how the parts of an atom are related.

atom	proton	nucleus
electron cloud	neutron	quark

## 1 Structure of the Atom (continued)

**Summarize** key ideas about quarks.

<b>Theories about Quarks</b>	<b>Finding Quarks</b>
<b>Detecting Quarks</b>	<b>Sixth Quark</b>

**Get It?** **Explain** the difference between a scaled-up model and a scaled-down model.

---

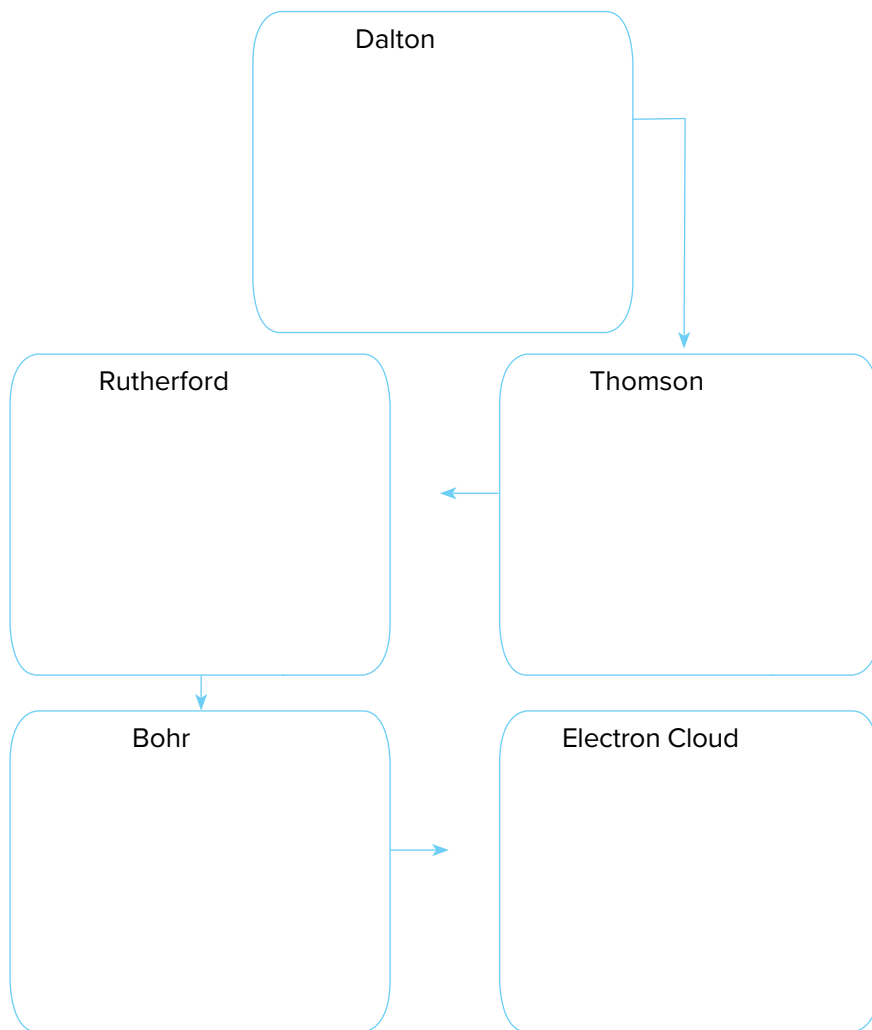
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## 1 Structure of the Atom (continued)

**Create** a time line of the changes that have occurred in modeling the atomic structure since the 1800s. Sketch and label each model.



**Get It? Explain** the difference between the Bohr model and the electron cloud model.

---

---

---

## 1 Structure of the Atom (continued)

### CHECK YOUR PROGRESS

1. **Identify** the names, charges, and locations of three types of subatomic particles that make up an atom.

---

---

---

2. **Identify** the chemical symbols for the elements carbon, aluminum, hydrogen, oxygen, and sodium.

---

3. **Describe** how quarks were discovered.

---

---

4. **Describe** how a rotating electric fan could function as a model of the atom. Explain how the rotating fan is unlike an atom.

---

---

---

5. **Math Connection** A proton's mass is estimated to be  $1.6726 \times 10^{-24}$  g, and the mass of an electron is estimated to be  $9.1093 \times 10^{-28}$  g. How many times larger is the mass of a proton compared to the mass of an electron?

---

---

# Properties of Atoms and the Periodic Table

## 2 Masses of Atoms

### REVIEW VOCABULARY

mass

Recall the definition of the Review Vocabulary term.

*mass*

### NEW VOCABULARY

atomic number

mass number

isotope

average atomic mass

Use your book to define each term.

*atomic number*

*mass number*

*isotope*

*average atomic mass*

## 2 Masses of Atoms (continued)

**Organize** the information on atomic mass to complete the outline.

### **Atomic Mass**

#### **A. Nucleus of atom**

1. \_\_\_\_\_  
\_\_\_\_\_
2. \_\_\_\_\_  
\_\_\_\_\_
3. \_\_\_\_\_  
\_\_\_\_\_

#### **B. Atomic mass unit**

1. \_\_\_\_\_
2. \_\_\_\_\_
3. \_\_\_\_\_

#### **C. Protons**

1. \_\_\_\_\_
2. \_\_\_\_\_
3. \_\_\_\_\_
4. \_\_\_\_\_

#### **D. Mass number**

1. \_\_\_\_\_  
\_\_\_\_\_
2. \_\_\_\_\_  
\_\_\_\_\_

## 2 Masses of Atoms (continued)

**Get It? Describe** how to determine whether or not an atom is boron.

---

---

**Get It? Interpret Table 4** to identify the element and the atomic number of the element with 29 protons.

---

---

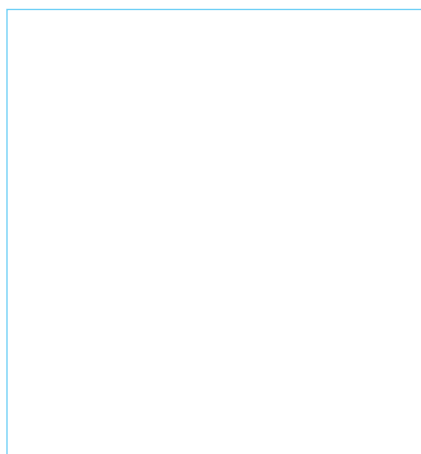
**Get It? Identify** What are isotopes?

---

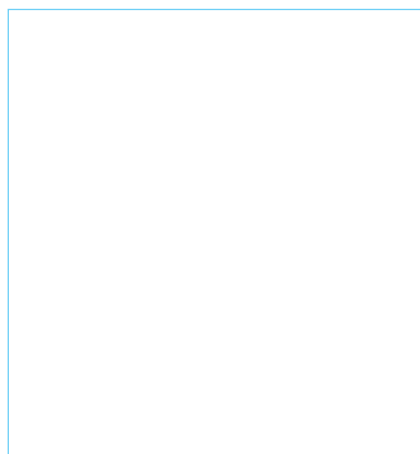
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**Model** carbon-12 and carbon-14 by sketching each atom.

- Remember that carbon's atomic number is 6.
- Label each atom's protons, neutrons, and electrons.
- Show the charges of the particles.



**Carbon-12**



**Carbon-14**

## 2 Masses of Atoms (continued)

**Get It? Compare** the following isotopes of chlorine in terms of mass number, number of protons, and number of neutrons: chlorine-35 and chlorine-37.

---

---

**Get It? Define** average atomic mass and explain how it is calculated.

---

---

---

**Analyze** how you would determine which isotope of an element is the most abundant if you know the element's average atomic mass.

---

---



## 2 Masses of Atoms (continued)

### CHECK YOUR PROGRESS

6. **Determine** the mass number and the atomic number of a chlorine atom that has 17 protons and 18 neutrons.

---

7. **Explain** how the isotopes of an element are alike and how they are different.

---

---

8. **Explain** why the atomic mass of an element is a weighted average mass.

---

---

---

9. **Calculate** the number of neutrons in potassium-40.

---

10. **Explain** Chlorine has an average atomic mass of 35.45 amu. The two naturally occurring isotopes of chlorine are chlorine-35 and chlorine-37. Do most chlorine atoms contain 18 neutrons or 20 neutrons? Why?

---

---

---

11. **Math Connection** Use the information in **Table 3** to determine the mass in kilograms of each subatomic particle.

---

---

---

# Properties of Atoms and the Periodic Table

## 3 The Periodic Table

### REVIEW VOCABULARY

chemical property

Recall the definition of the Review Vocabulary term.

chemical property

### NEW VOCABULARY

periodic table

period

group

electron dot diagram

Use your book to define each term.

periodic table

period

group

electron dot diagram

### 3 The Periodic Table (continued)

**Get It? Explain** how Mendeleev was able to predict the properties of elements that had not yet been discovered.

---

---

---

**Get It? Explain** how Mendeleev organized his periodic table.

---

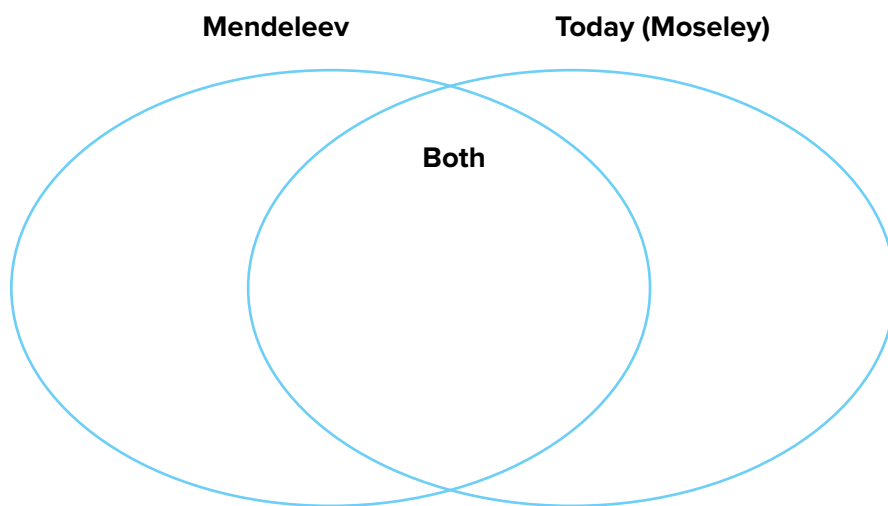
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**Get It? Describe** how Moseley altered the arrangement of elements on the periodic table and how the change improved the table.

---

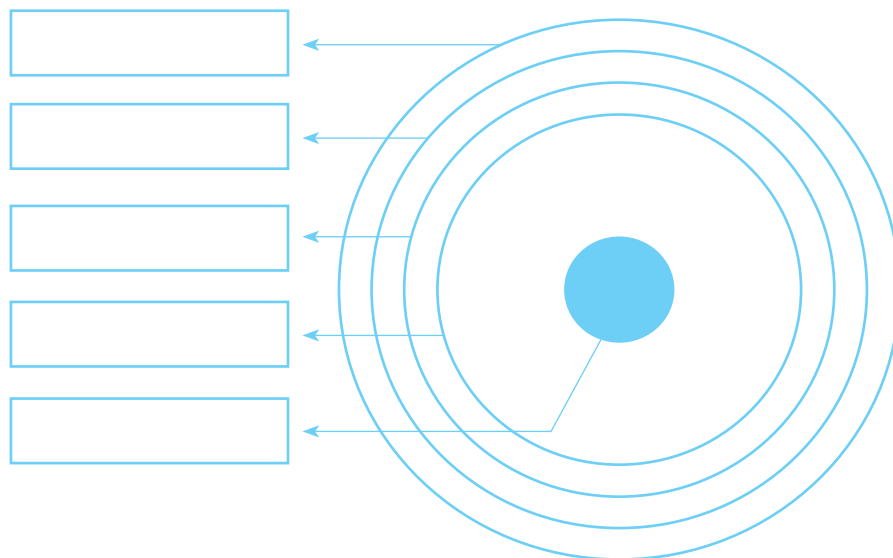
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**Compare** Mendeleev's early periodic table to that of today by completing the Venn diagram.



### 3 The Periodic Table (continued)

**Sequence** the energy levels in the electron cloud diagram and write the maximum number of electrons that can be contained in each level.



**Analyze** how electron dot diagrams show similarities between elements within a group.

---

---

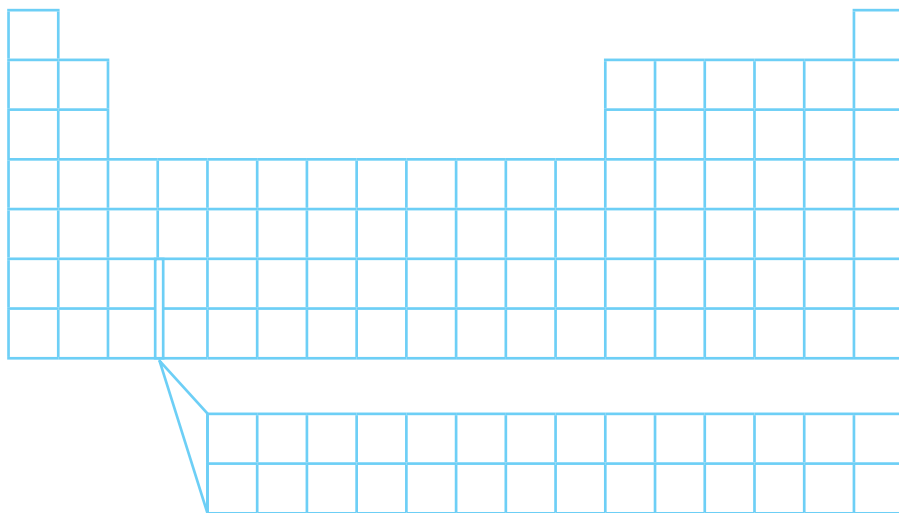
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### 3 The Periodic Table (continued)

**Classify** the regions of the periodic table as metals, nonmetals, or metalloids.

- Shade the regions on the blank periodic table.
- Label each region and write its characteristics.



### 3 The Periodic Table (continued)

#### CHECK YOUR PROGRESS

- 12. Relate** Use the periodic table to find the name, atomic number, atomic mass, and the number of outermost electrons for each of the following elements: N, P, As, and Sb.

---

---

- 13. Provide** the symbol, the group number, and the period of each of the following elements: nitrogen, sodium, iodine, and mercury.

---

---

- 14. Classify** each of the following elements as a metal, a nonmetal, or a metalloid and give the full name of each element: K, Si, and S.

---

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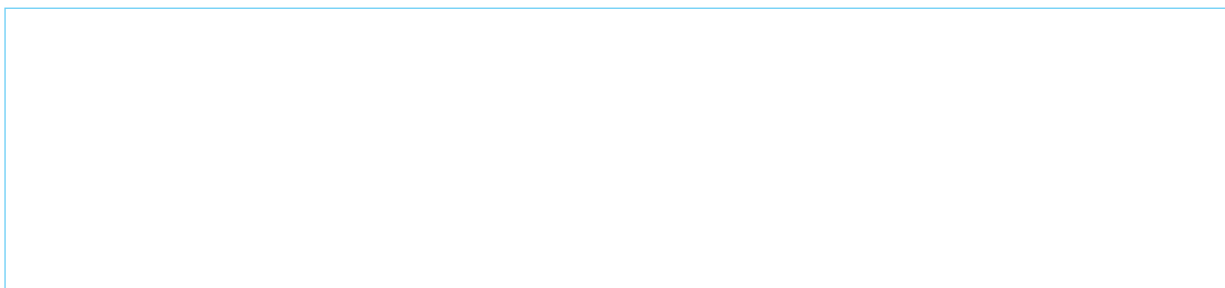
- 15. Explain** The Mendeleev and Moseley periodic charts had gaps for undiscovered elements. Why do you think the chart used by Moseley was more accurate at predicting where new elements would be placed?

---

---

---

- 16. Math Connection** Construct a circle graph showing the percentage of elements classified as metals, metalloids, and nonmetals. Use markers or colored pencils to distinguish clearly between each section on the graph.



# 17 Elements and Their Properties

## ENCOUNTER THE PHENOMENON

Write the Encounter the Phenomenon question for this module.

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---

---

Use the “What I Know” column to list the things you know about the Encounter the Phenomenon question. Then list the questions you have about the Encounter the Phenomenon question in the “What I Want to Find Out” column. As you read the module, fill in the “What I Learned” column.

K <i>What I Know</i>	W <i>What I Want to Find Out</i>	L <i>What I Learned</i>

# Elements and Their Properties

## 1 Metals

### REVIEW VOCABULARY

group

Recall the definition of the Review Vocabulary term.

*group*

### NEW VOCABULARY

ductile

malleable

metal

metallic bonding

radioactive element

transition element

Use your book to define each term.

*ductile*

*malleable*

*metal*

*metallic bonding*

*radioactive element*

*transition element*



## 1 Metals (continued)

**Complete** the outline about the physical properties and bonds of metals.

### I. Metals

#### A. Physical Properties

---

---

---

#### B. Bonding

##### 1. Ionic Bonding

---

---

##### 2. Metallic Bonding

---

---

**Get It? Explain** how knowledge of the properties of alkali metals is used to predict how they will react and how they should be stored.

---

---

**Get It? Explain** how the interactions of electric charges at the atomic scale explain the reactivity of alkali metals.

---

---

---

**Get It? Explain** how the location of alkali metals on the periodic table is related to the state of their outer electron energy level.

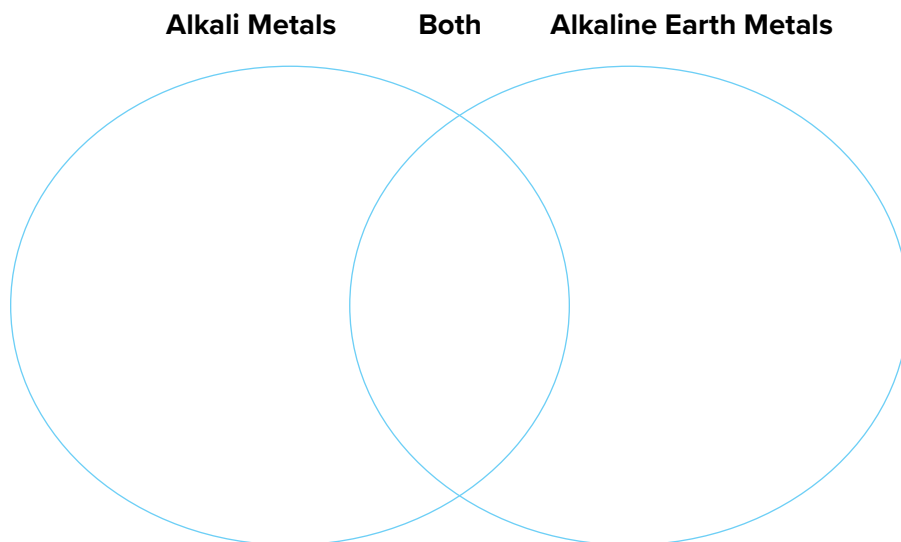
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## 1 Metals (continued)

**Get It?** Compare the alkali and alkaline earth metals.

Use the Venn diagram.



**Get It?** Explain why gold's relative softness makes it a good choice for jewelry.

---

---

**Get It?** Explain why the first row of inner transition elements is called the lanthanide series.

---

---

**Sequence** the steps used to extract metal from Earth's crust.

1. 

---
2. 

---
3. 

---
4. 

---

## 1 Metals (continued)

### CHECK YOUR PROGRESS

1. **Describe** how to test a sample of an element to see if it is a metal.

---

---

2. **Compare and contrast** the uses of the iron triad and the use of the coinage metals.

---

---

3. **Classify** the following as alkali metals, alkaline earth metals, transition elements, or inner transition elements: calcium, gold, iron, magnesium, plutonium, potassium, sodium, and uranium.

---

---

4. **Discuss** how metallic bonding accounts for the common properties of metals.

---

---

---

---

---

5. **Determine** Suppose you discovered a new element with 120 protons and 2 electrons in its outer level. In what group does this new element belong? What properties would you expect it to have?

---

---

---

6. **Math Connection** Pennies used to be made of copper and zinc and had a mass of 3.1 g. Today, pennies are made of copper-plated zinc and have a mass of 2.5 g. A new penny's mass is what percent of an old penny's mass?

---

# Elements and Their Properties

## 2 Nonmetals

### REVIEW VOCABULARY

sublimation

Recall the definition of the Review Vocabulary term.

*sublimation*

### NEW VOCABULARY

diatomic molecule

nonmetal

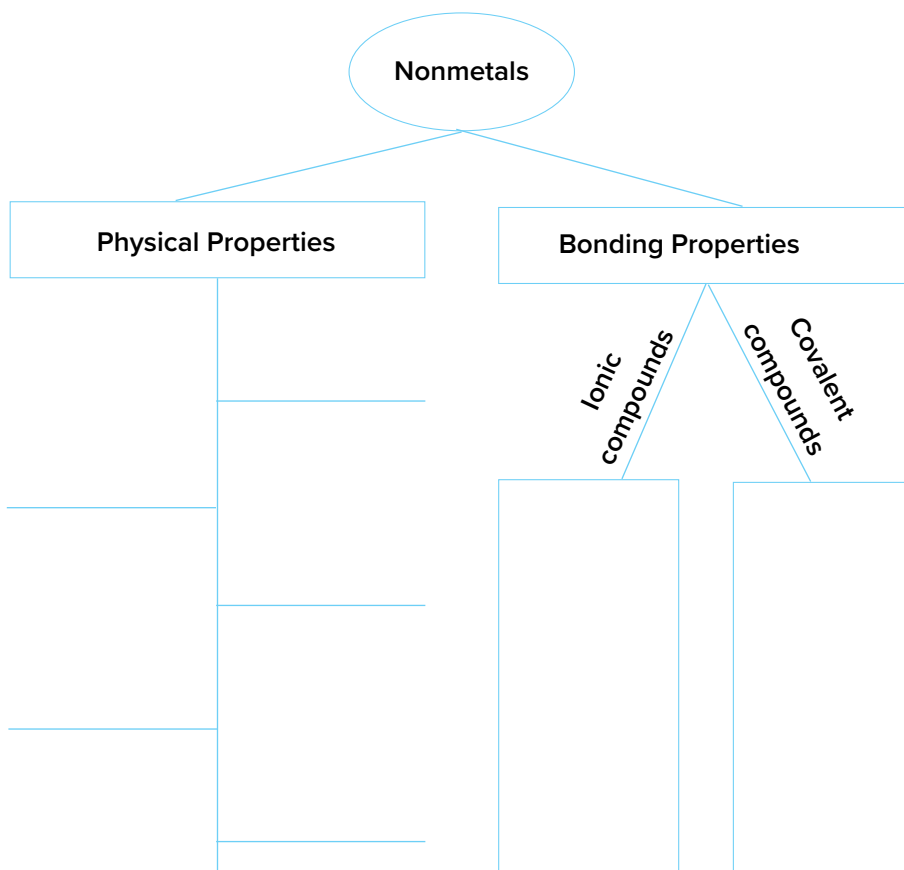
Use your book to define each term.

*diatomic molecule*

*nonmetal*

## 2 Nonmetals (continued)

**Organize** the physical and bonding properties of nonmetals by completing the concept map.



**Classify** hydrogen as a Group 1 metal and as a nonmetal. In the table below, list the reasons it could be placed in each group of the periodic table.

Group 1 Metal	Nonmetal

## 2 Nonmetals (continued)

**Complete** the graphic organizer with facts about halogens.

Halogens are the Group \_\_\_\_\_ elements. They are highly reactive and have \_\_\_\_\_ in their outer shell. They become \_\_\_\_\_ when they gain an electron from a metal. The resulting compound is a \_\_\_\_\_. Halogens can also share electrons to form \_\_\_\_\_ compounds.

Fluorine

Chlorine

Bromine

Iodine

Astatine

**Get It?** Name some uses of chlorine and bromine compounds.

**Distinguish** the noble gases from other elements by writing their characteristics and uses in the spaces provided.

Noble gases are isolated \_\_\_\_\_. They are stable because their outermost energy levels are \_\_\_\_\_. Helium is \_\_\_\_\_ dense than air but does not burn in \_\_\_\_\_. It is used in \_\_\_\_\_ and balloons. An electric current will cause the noble gases to \_\_\_\_\_. Neon and \_\_\_\_\_ are used for brightly colored signs.

## 2 Nonmetals (continued)

### CHECK YOUR PROGRESS

7. **Explain** how nonmetals are different from solid metals.

---

---

---

---

8. **Describe** two ways in which nonmetals combine with other elements.

---

9. **Identify** the nonmetal in these compounds:  $\text{MgO}$ ,  $\text{NaH}$ ,  $\text{AlBr}_3$ , and  $\text{FeS}$ .

---

10. **Identify** some common uses for the halogen compounds.

---

---

---

---

11. **Explain** why the noble gases are unreactive.

---

---

---

12. **Describe** How can you tell that a gas is a halogen?

---

---

13. **Math Connection** If a chlorine atom has a mass of 35.5 atomic mass units and a sodium atom has a mass of 23.0 atomic mass units, what is the mass of one  $\text{NaCl}$  unit?

---

# Elements and Their Properties

## 3 Mixed Groups

### REVIEW VOCABULARY

substance

Recall the definition of the Review Vocabulary term.

substance

### NEW VOCABULARY

allotrope

metalloid

semiconductor

transuranium element

Use your book to define each term.

allotrope

metalloid

semiconductor

transuranium element



### 3 Mixed Groups (continued)

**Summarize** the characteristics of metalloids.

---

---

---

**Complete** the graphic organizer with facts about the Boron Group.

Characteristics and Uses	
Aluminum	Boron

**Organize** the properties and uses of the Carbon Group in the chart below.

	Properties	Uses
Carbon		
Silicon		
Germanium		
Tin and Lead		

### 3 Mixed Groups (continued)

**Get It? Define** the term *allotrope*.

---

---

**Compare** the nitrogen and oxygen groups. List three characteristics these two groups have in common.

1. 

---
2. 

---
3. 

---

**Classify** these elements as nonmetal, metalloid, or metal. Use the periodic table in your book to help you.

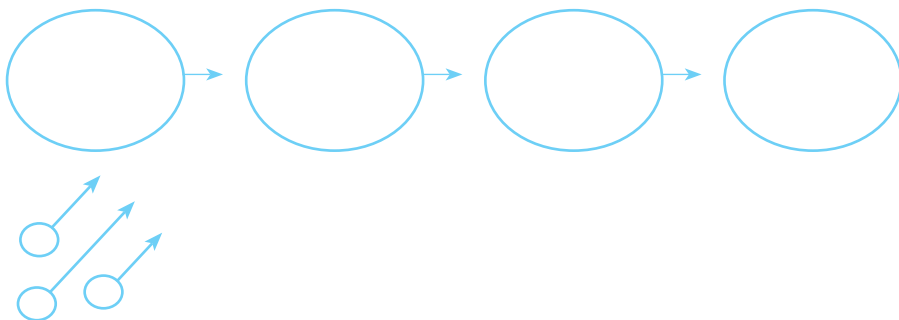
arsenic	<hr/>	selenium	<hr/>
antimony	<hr/>	tellurium	<hr/>
bismuth	<hr/>	polonium	<hr/>

**Get It? Explain** why bismuth is used in fire-sprinkler heads.

---

---

**Use** the diagram to model how scientists produce americium.



### 3 Mixed Groups (continued)

#### CHECK YOUR PROGRESS

- 14. Explain** why groups 14 and 15 are better representatives of mixed groups than groups 13 and 16.

---

---

- 15. Define** the term *semiconductor* and give an example of a metalloid that is used to make semiconductors.

---

---

---

- 16. Compare and contrast** natural elements and synthetic elements.

---

---

---

- 17. Describe** the differences and similarities between metals, nonmetals, and metalloids.

---

---

---

- 18. Explain** Graphite and diamond are made of the element carbon. Explain why graphite is a lubricant and diamond is the hardest gem known.

---

---

---

- 19. Math Connection** An isotope of copernicium has 112 protons and 173 neutrons. How many particles are in the nucleus of the atom?

---



# 18 Chemical Bonds

## ENCOUNTER THE PHENOMENON

Write the Encounter the Phenomenon question for this module.

---

---

---

Use the “What I Know” column to list the things you know about the Encounter the Phenomenon question. Then list the questions you have about the Encounter the Phenomenon question in the “What I Want to Find Out” column. As you read the module, fill in the “What I Learned” column.

K <i>What I Know</i>	W <i>What I Want to Find Out</i>	L <i>What I Learned</i>

# Chemical Bonds

## 1 Stability in Bonding

### REVIEW VOCABULARY

compound

Recall the definition of the Review Vocabulary term.

*compound*

### NEW VOCABULARY

chemical formula

chemical bond

Use your book to define each term.

*chemical formula*

*chemical bond*

## 1 Stability in Bonding (continued)

**Compare** copper sulfate with the elements that form copper sulfate.

---

---

---

---

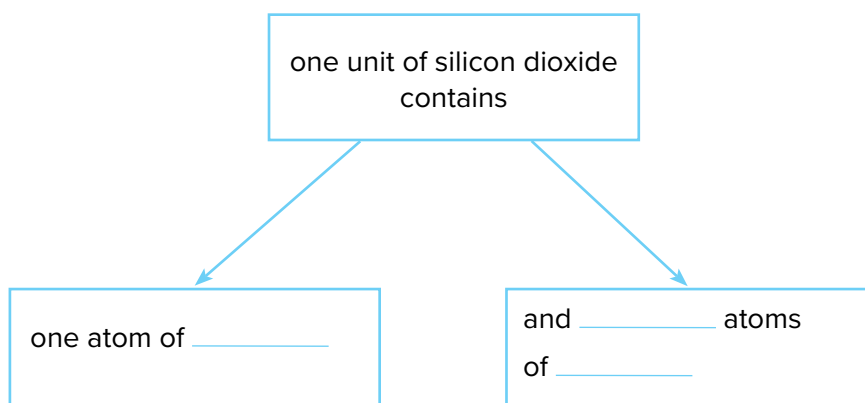
**Get It? Interpret** What does a chemical formula show you?

---

---

---

**Complete** the graphic organizer. Use **Table 1** in your textbook for information.



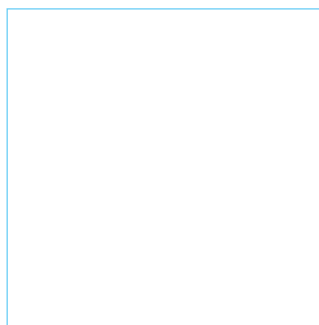
**Get It? Explain** why the noble gases are unusually stable.

---

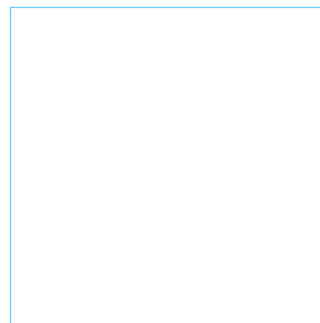
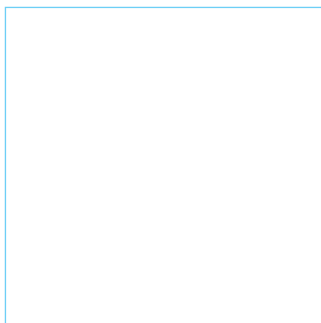
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## 1 Stability in Bonding (continued)

**Summarize** what can be learned about an element from its electron dot diagram. Then draw an electron dot diagram of lithium below your answer. Use the examples of electron dot diagrams in your book for help.



**Create** electron dot diagrams for sodium and chlorine. Explain how both atoms could become more stable.



**Complete** the statements about chemical bonds.

When atoms of different elements \_\_\_\_\_, \_\_\_\_\_, or \_\_\_\_\_ electrons, an attraction forms between the \_\_\_\_\_, resulting in the formation of a \_\_\_\_\_. The attraction is called a \_\_\_\_\_.



## 1 Stability in Bonding (continued)

### CHECK YOUR PROGRESS

1. **Explain** why some elements are stable on their own, while others are more stable in compounds.

---

---

---

2. **Compare and contrast** the properties of potassium (K) and iodine (I) with the compound KI.

---

---

---

3. **Identify** what the electron dot diagram tells you about bonding.

---

---

---

4. **Explain** why electric forces are essential to forming compounds.

---

---

---

## 1 Stability in Bonding (continued)

### CHECK YOUR PROGRESS

5. **Describe** why chemical bonding occurs. Give two examples of how bonds can form.

---

---

---

---

6. **Interpret** The label on a box of cleanser states that it contains  $\text{CH}_3\text{COOH}$ . What elements are in this compound? How many atoms of each element can be found in a unit of  $\text{CH}_3\text{COOH}$ ?

---

---

7. **Math Connection** Given that the molecular mass of magnesium hydroxide ( $\text{Mg}(\text{OH})_2$ ) is 58.32 amu and the atomic mass of an atom of oxygen is 15.999 amu, what percentage of this compound is oxygen?

---

---

# Chemical Bonds

## 2 Types of Bonds

### REVIEW VOCABULARY

atom

Recall the definition of the Review Vocabulary term.

atom

### NEW VOCABULARY

Write the correct vocabulary term in the left column for each definition below.

a charged particle that has either more or fewer electrons than it has protons

the force of attraction between a positive ion and a negative ion in an ionic compound

the force of attraction between two atoms that share electrons

the neutral particle that forms when atoms share electrons

a covalent bond in which the electrons are shared equally

a covalent bond in which electrons are shared unequally

a molecule that has a slightly positive end and a slightly negative end

a molecule that shares electrons equally and does not have oppositely charged ends

## 2 Types of Bonds (continued)

**Complete** the steps in the formation of a potassium ion.

1. An atom of potassium has \_\_\_\_\_ electron in its \_\_\_\_\_ energy level.
2. A potassium atom \_\_\_\_\_ one electron in its outer energy level when it combines with an iodine atom.
3. The potassium atom is now an \_\_\_\_\_.
4. The potassium ion has a charge of \_\_\_\_\_.
5. The symbol for a potassium ion is \_\_\_\_\_.

**Analyze** Why are Group 14 elements much more likely to share electrons than transfer electrons?

---

---

---

---

**Get It? Explain** What part of an ion's symbol indicates its charge?

---

---

**Get It? Explain** why an atom of iodine tends to react to gain one electron.

---

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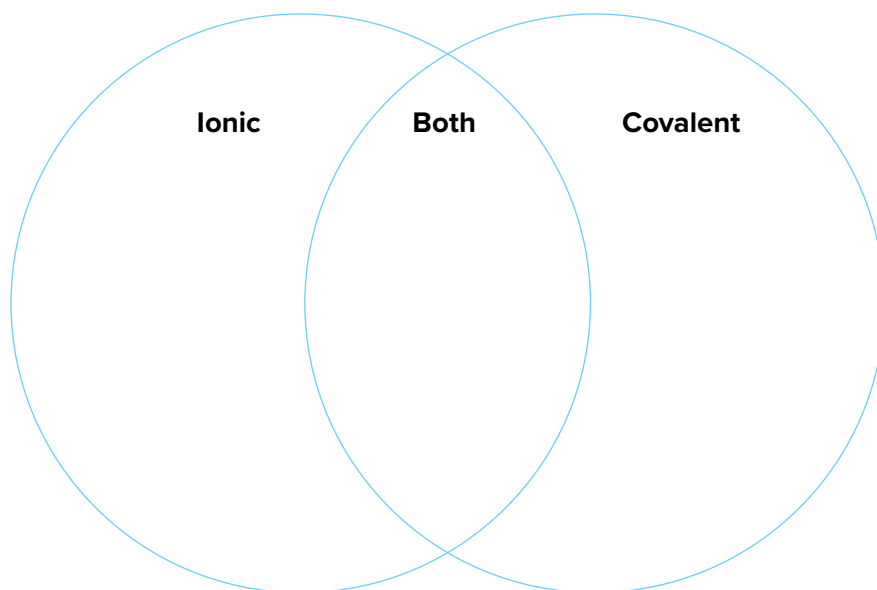
## 2 Types of Bonds (continued)

**Get It? Explain** What is the charge of an ionic compound?

---

---

**Compare** ionic and covalent bonds in the Venn diagram below with at least six facts.



**Get It? Describe** the atoms involved in a nonpolar bond.

---

---

**Evaluate** Your friend says that nonpolar molecules cannot contain polar bonds. Do you agree? Support your answer.

---

---

---

## 2 Types of Bonds (continued)

### CHECK YOUR PROGRESS

8. **Compare and contrast** ionic and covalent bonds.

---

---

9. **Determine** the type of bonding in CaO and in SO<sub>2</sub>.

---

10. **Name** the type of particle formed by covalent bonds.

---

11. **Identify** the following substances as having polar or nonpolar molecules: HBr, Cl<sub>2</sub>, and H<sub>2</sub>O.

---

---

---

12. **Predict** From the given symbols, choose two elements that are likely to form an ionic bond: O, Ne, S, Ca, and K. Next, select two elements that would likely form a covalent bond. Explain your predictions.

---

---

---

13. **Math Connection** Aluminum oxide (Al<sub>2</sub>O<sub>3</sub>) can be produced during rocket launches. Show that the sum of the positive and negative charges in a unit of Al<sub>2</sub>O<sub>3</sub> equals zero.

---

# Chemical Bonds

## 3 Writing Formulas and Naming Compounds

### REVIEW VOCABULARY

ion

Recall the definition of the Review Vocabulary term.

ion

### NEW VOCABULARY

oxidation number

binary compound

polyatomic ion

hydrate

Use your book to define each term.

oxidation number

binary compound

polyatomic ion

hydrate

### 3 Writing Formulas and Naming Compounds (continued)

**Complete** the table below for sodium and chlorine. Use the periodic table in your book.

Element	Oxidation Number	Positive or negative charge on ion formed?
sodium		
chlorine		

**Get It? Determine** the oxidation numbers for each of the ions in the ionic compound calcium bromide,  $\text{CaBr}_2$ .

---

**Get It? Determine** the oxidation number of lead in the ion lead(IV).

---

**Summarize** the three steps in writing a formula for an ionic compound by completing the graphic organizer below.

1.

2.

3.



### 3 Writing Formulas and Naming Compounds (continued)

**Organize** the steps for finding the formula for ammonium sulfate by completing the questions and answers below. Look at **Table 4** in your textbook for help.

Question: What is the positive ion and its charge?

Answer: \_\_\_\_\_  
\_\_\_\_\_

Question: What is the negative ion and its charge?

Answer: \_\_\_\_\_  
\_\_\_\_\_

Question: How can the charges be balanced to make the compound neutral?

Answer: \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

Question: What is the formula?

Answer: \_\_\_\_\_

**Get It? Determine** What is the name of  $\text{Na}_2\text{CO}_3$ ?

\_\_\_\_\_

**Get It? Write** the name of the compound  $\text{S}_2\text{O}_3$ .

\_\_\_\_\_

### 3 Writing Formulas and Naming Compounds (continued)

**Analyze** the following covalent compounds. Write the name for each compound in the right column. Use **Table 6** in your book for help. In the final row, write the formula and name of a binary covalent compound of your choice.

Formula	Name
$\text{N}_2\text{O}_5$	
$\text{SF}_6$	
$\text{CCl}_4$	
$\text{Cl}_2\text{O}$	
$\text{CO}$	
$\text{IF}_7$	

**Summarize** what you know about hydrates by filling in the blanks below.

A \_\_\_\_\_ has water chemically attached to its atoms and written into its \_\_\_\_\_. The \_\_\_\_\_ can be removed from the crystals by \_\_\_\_\_ them. The form of the compound without water is described as \_\_\_\_\_. The formula  $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$  is named \_\_\_\_\_. Its common name is \_\_\_\_\_. The \_\_\_\_\_ form of this hydrate is calcium sulfate.

### 3 Writing Formulas and Naming Compounds (continued)

#### CHECK YOUR PROGRESS

**20. Predict** formulas for the following compounds: potassium iodide, phosphorus pentachloride, magnesium hydroxide, aluminum sulfate, dichlorine heptoxide, and calcium nitrate trihydrate.

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**21. Write** the names of these compounds:  $\text{Al}_2\text{O}_3$ ,  $\text{Ba}(\text{ClO}_3)_2$ ,  $\text{SO}_2$ ,  $\text{NH}_4\text{Cl}$ ,  $\text{PCl}_3$ , and  $\text{Mg}_3(\text{PO}_4)_2 \cdot 4\text{H}_2\text{O}$ .

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---

**22. Determine** the oxidation number of each atom in the following compounds: sodium chloride and iron(II) oxide.

---

---

**23. Explain** whether sodium and potassium will react to form a bond with each other.

---

---

**24. Math Connection** The overall charge on the polyatomic sulfate ion is  $2-$ . Its formula is  $\text{SO}_4^{2-}$ . If the oxygen ion has a  $2-$  oxidation number, determine the oxidation number of sulfur in this polyatomic ion.

---



# 19 Chemical Reactions

## ENCOUNTER THE PHENOMENON

Write the Encounter the Phenomenon question for this module.

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Use the “What I Know” column to list the things you know about the Encounter the Phenomenon question. Then list the questions you have about the Encounter the Phenomenon question in the “What I Want to Find Out” column. As you read the module, fill in the “What I Learned” column.

<b>K</b> <i>What I Know</i>	<b>W</b> <i>What I Want to Find Out</i>	<b>L</b> <i>What I Learned</i>

# Chemical Reactions

## 1 Chemical Changes

### REVIEW VOCABULARY

chemical formula

Recall the definition of the Review Vocabulary term.

*chemical formula*

### NEW VOCABULARY

chemical reaction

reactants

products

chemical equation

coefficient

balanced chemical  
equation

mole

molar mass

Use your book to define each term.

*chemical reaction*

*reactants*

*products*

*chemical equation*

*coefficient*

*balanced chemical equation*

*mole*

*molar mass*

## 1 Chemical Changes (continued)

**Summarize** the contributions of Lavoisier by completing the paragraph.

The French chemist Antoine \_\_\_\_\_ discovered the law of \_\_\_\_\_ of \_\_\_\_\_. This law states that the total mass of the \_\_\_\_\_ always equals the total mass of the \_\_\_\_\_. Another way to say this is that mass is neither \_\_\_\_\_ nor \_\_\_\_\_ in a chemical reaction.

**Get It?** **Explain** the law of conservation of mass.

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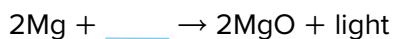
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**Identify** the reactants and the products in the following chemical equations.

Chemical Equation	Reactant(s)	Product(s)
$\text{Zn} + \text{S} \rightarrow \text{ZnS}$		
$\text{AgNO}_3 + \text{NaCl} \rightarrow \text{AgCl} + \text{NaNO}_3$		
$\text{C}_{12}\text{H}_{22}\text{O}_{11} \rightarrow 12\text{C} + 11\text{H}_2\text{O}$		
$\text{CaCO}_3 + 2\text{HCl} \rightarrow \text{H}_2\text{O} + \text{CO}_2 + \text{CaCl}_2$		

**Complete** the following chemical equation and its translation.



Magnesium \_\_\_\_\_ oxygen  
\_\_\_\_\_ magnesium oxide  
and \_\_\_\_\_ energy.

## 1 Chemical Changes (continued)

**Complete** the table of symbols used in chemical equations.

Symbol	Meaning
	produces or yields
+	
(s)	
	liquid
(g)	
	aqueous (substance is dissolved in water)
$\xrightarrow{\text{heat}}$	The reactants are _____.
$\xrightarrow{\text{light}}$	
	An electric current is applied to the reactants.

**Get It? Summarize** Describe the role of coefficients in a chemical equation.

---

---

---

**Get It? Summarize** How can you tell whether a chemical equation is balanced or not?

---

---

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## 1 Chemical Changes (continued)

**Complete** the table below. The number of atoms for each element on the left side of the equation has been filled in for you. Fill in the number of atoms for the right side of the equation.

**Number and Kinds of Atoms**

	$\text{BaCl}_2 + \text{H}_2\text{SO}_4 \rightarrow \text{BaSO}_4 + \text{HCl}$			
<b>Ba</b>	1			
<b>Cl</b>	2			
<b>H</b>		2		
<b>S</b>		1		
<b>O</b>		4		

**Evaluate** whether the equation above is balanced. Does every element have the same number of atoms on each side of the equation? If not, which ones are not equal?

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**Determine** what coefficient could be added to balance the equation from the table. Write the balanced equation below.

---

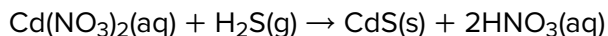
**Identify** coefficients that balance each equation. Leave a blank space if no coefficient is needed.

1.  $\text{P(s)} + \text{O}_2\text{(g)} \rightarrow \text{P}_4\text{O}_{10}\text{(s)}$
2.  $\text{KClO}_3\text{(s)} \rightarrow \text{KCl(s)} + \text{O}_2\text{(g)}$
3.  $\text{H}_2\text{O(l)} \rightarrow \text{H}_2\text{(g)} + \text{O}_2\text{(g)}$
4.  $\text{CH}_4\text{(s)} + \text{O}_2\text{(g)} \rightarrow \text{CO}_2\text{(g)} + \text{H}_2\text{O(g)}$
5.  $\text{Al}_2\text{O}_3\text{(s)} \rightarrow \text{Al(s)} + \text{O}_2\text{(g)}$
6.  $\text{MgSO}_4\text{(aq)} + \text{KCl(aq)} \rightarrow$   
 $\text{MgCl}_2\text{(s)} + \text{K}_2\text{SO}_4\text{(aq)}$

## 1 Chemical Changes (continued)

### CHECK YOUR PROGRESS

5. **Identify** the reactants and the products in the following chemical equation:



6. **Explain** the importance of the law of conservation of mass.

7. **Explain** why oxygen gas must be written as  $\text{O}_2$  in a chemical equation.

8. **Explain** why the sum of the coefficients on the reactant side of a balanced equation does not have to equal the sum of the coefficients on the product side of the equation.

9. **Math Connection** Balance the following equation:  $\text{Fe}(\text{s}) + \text{Cl}_2(\text{g}) \rightarrow \text{FeCl}_3(\text{s})$ .

10. **Math Connection** Calculate how many moles are in 125 g of water ( $\text{H}_2\text{O}$ ).

11. **Math Connection** Calculate the mass of 3.000 mol of calcium (Ca).

# Chemical Reactions

## 2 Classifying Chemical Reactions

### REVIEW VOCABULARY

states of matter

Recall the definition of the Review Vocabulary term.

states of matter

### NEW VOCABULARY

combustion reaction

synthesis reaction

decomposition reaction

single-displacement  
reaction

double-displacement  
reaction

precipitate

oxidation

reduction

Use your book to define each term.

combustion reaction

synthesis reaction

decomposition reaction

single-displacement reaction

double-displacement reaction

precipitate

oxidation

reduction

## 2 Classifying Chemical Reactions (continued)

**Describe** each type of chemical reaction in words. Give the general form if it exists and an example for each.

Combustion reaction	Description:
	Example:
Synthesis reaction	Description:
	General form:
	Example:
Decomposition reaction	Description:
	General form:
	Example:
Single-displacement reaction	Description:
	General form:
	Example:
Double-displacement reaction	Description:
	General form:
	Example:
Oxidation-reduction reaction	Description:

**Get It? Summarize** Describe what happens in a single-displacement reaction.

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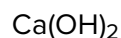
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## 2 Classifying Chemical Reactions (continued)

**Classify** each of the following reactions by writing what type of reaction it is in the space to the right.

Reaction	Type of reaction
$\text{NiCl} \rightarrow \text{Ni} + \text{Cl}_2$	
$2\text{LiBr} + \text{PbNO}_3 \rightarrow \text{PbBr}_2 + 2\text{LiNO}_3$	
$\text{Fe} + 2\text{HCl} \rightarrow \text{FeCl}_2 + \text{H}_2$	
$\text{H}_2 + \text{Cl}_2 \rightarrow 2\text{HCl}$	

**Model** a synthesis reaction and a decomposition reaction using the following 3 substances in chemical equations.



Synthesis reaction: \_\_\_\_\_

Decomposition reaction: \_\_\_\_\_

**Interpret** the activity series (**Figure 10** in your textbook) to decide which metal will replace the other in a displacement reaction.

Metal 1	Metal 2	Which would replace the other?
calcium	lead	
tin	zinc	
copper	aluminum	
gold	silver	

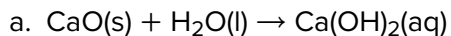
**Get It? Classify** What kind of reaction produces a precipitate?

\_\_\_\_\_

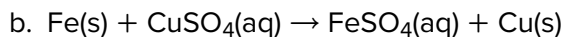
## 2 Classifying Chemical Reactions (continued)

### CHECK YOUR PROGRESS

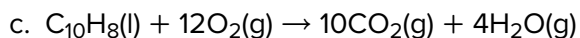
**12. Characterize** each reaction by determining its reaction type.



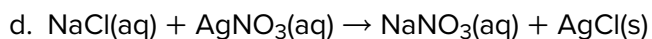
\_\_\_\_\_



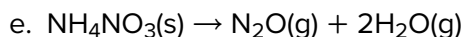
\_\_\_\_\_



\_\_\_\_\_



\_\_\_\_\_



\_\_\_\_\_

**13. Describe** what happens in a combustion reaction.

\_\_\_\_\_

**14. Compare and contrast** synthesis reactions and decomposition reactions.

\_\_\_\_\_

\_\_\_\_\_

**15. Determine,** using **Figure 10** from your textbook, if zinc will displace gold in a chemical reaction, and explain why or why not.

\_\_\_\_\_

**16. Describe** one possible economic impact of redox reactions. How might that impact be lessened?

\_\_\_\_\_

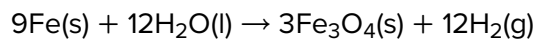
\_\_\_\_\_

\_\_\_\_\_

## 2 Classifying Chemical Reactions (continued)

### CHECK YOUR PROGRESS (CONTINUED)

- 17. Math Connection** The following chemical reaction is balanced, but the coefficients used are larger than necessary. Rewrite this balanced equation using the smallest coefficients possible.



- 18. Math Connection** Sulfur trioxide ( $\text{SO}_3$ ), a pollutant released by coal-burning plants, can react with water ( $\text{H}_2\text{O}$ ) in the atmosphere to produce sulfuric acid ( $\text{H}_2\text{SO}_4$ ). Write the balanced equation for this reaction.
-

# Chemical Reactions

## 3 Chemical Reactions and Energy

### REVIEW VOCABULARY

chemical bond

Recall the definition of the Review Vocabulary term.

*chemical bond*

### NEW VOCABULARY

exergonic reaction

exothermic reaction

endergonic reaction

endothermic reaction

Use your book to define each term.

*exergonic reaction*

*exothermic reaction*

*endergonic reaction*

*endothermic reaction*



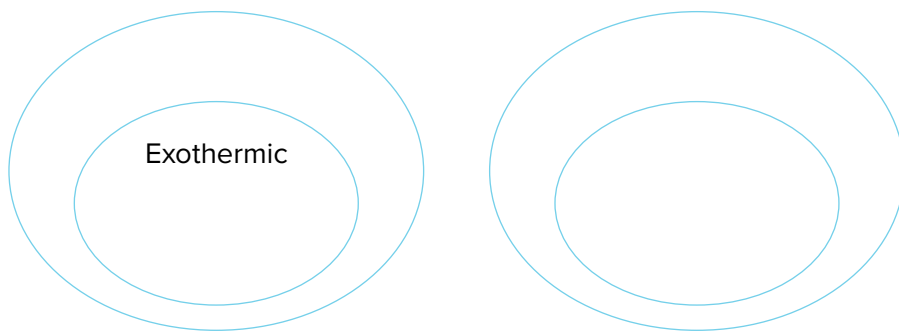
### 3 Chemical Reactions and Energy (continued)

**Complete** the following passage about energy in chemical reactions.

All exothermic reactions are \_\_\_\_\_, but not all exergonic reactions are \_\_\_\_\_. \_\_\_\_\_ reactions give off thermal energy, and \_\_\_\_\_ reactions give off any type of energy.

All \_\_\_\_\_ reactions are endergonic, but not all \_\_\_\_\_ reactions are endothermic. \_\_\_\_\_ reactions absorb thermal energy, and \_\_\_\_\_ reactions absorb any type of energy.

**Model** the relationships between exergonic, exothermic, endergonic, and endothermic reactions by completing the Venn diagram below. The first step has been done for you.



**Get It? Infer** Why is a log fire considered to be an exothermic reaction?

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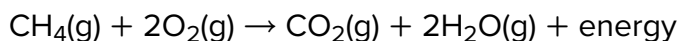
### 3 Chemical Reactions and Energy (continued)

**Classify** each of the following processes as endergonic or exergonic.

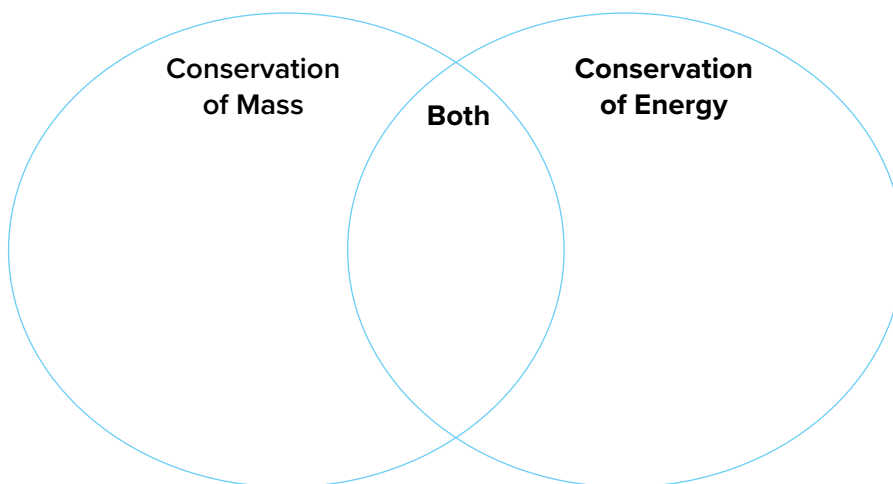
combustion of fossil fuels	glow sticks
dissolving salt in water	photosynthesis
dynamite explosions	rusting iron
electroplating	separating aluminum from its ore
firefly light	

Exergonic	Endergonic

**Compare and contrast** the conservation of mass and the conservation of energy in the equation below. Fill in the Venn diagram using phrases from the bank below the equation.



The equation is balanced.	Light is a product.
Energy is not created or destroyed.	Matter is not created or destroyed.
New compounds are created.	Chemical energy is released as thermal energy.
Atoms on the left are the same as atoms on the right.	



### 3 Chemical Reactions and Energy (continued)

#### CHECK YOUR PROGRESS

**19. Classify** the chemical reaction photosynthesis as endergonic or exergonic. Explain.

---

---

**20. Explain** why the total amount of energy does not decrease in an exergonic chemical reaction.

---

---

---

**21. Explain** how a reaction could be endergonic but not endothermic.

---

---

---

**22. Classify** the reaction that makes a firefly glow in terms of energy input and output.

---

**23. Apply** To develop a product that warms people's hands, would you use an exothermic or endothermic reaction? Why?

---

**24. Math Connection** If an endothermic reaction begins at  $26^{\circ}\text{C}$  and decreases by  $2^{\circ}\text{C}$  per minute, how long will it take to reach  $0^{\circ}\text{C}$ ?

---

**25. Math Connection** Create a graph of the data in question 24. After 5 minutes, what is the temperature of the reaction?

---

# Chemical Reactions

## 4 Reaction Rates and Equilibrium

### REVIEW VOCABULARY

pressure

Recall the definition of the Review Vocabulary term.

pressure

### NEW VOCABULARY

reaction rate

Use your book to define each term.

reaction rate

collision model

collision model

catalyst

catalyst

inhibitor

reversible reaction

equilibrium

inhibitor

Le Châtelier's principle

reversible reaction

equilibrium

Le Châtelier's principle

## 4 Reaction Rates and Equilibrium (continued)

**Complete** the table to show how each of the factors in the table can either speed up or slow down a reaction.

Factor	Speed up a reaction by...	Slow down a reaction by...
Temperature	increasing temperature.	
Concentration		decreasing concentration of the reactants.
Pressure	increasing pressure of a gas.	
Volume	decreasing the volume of a gas.	
Surface area		decreasing surface area of reactants.
Catalyst		removing the catalyst.
Inhibitor	removing an inhibitor.	

**Get It?** Use the collision model to explain the effect of increased temperature on reaction rates.

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**Get It?** Use the collision model to predict how the reaction rate changes over time as a magnesium ribbon reacts with HCl in a dilute HCl solution.

---

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---

---

## 4 Reaction Rates and Equilibrium (continued)

**Get It?** Compare and contrast the effects of increased concentration of liquid reactants and decreased volume of gaseous reactants.

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**Get It?** Compare and contrast catalysts and inhibitors in how they affect reaction rates.

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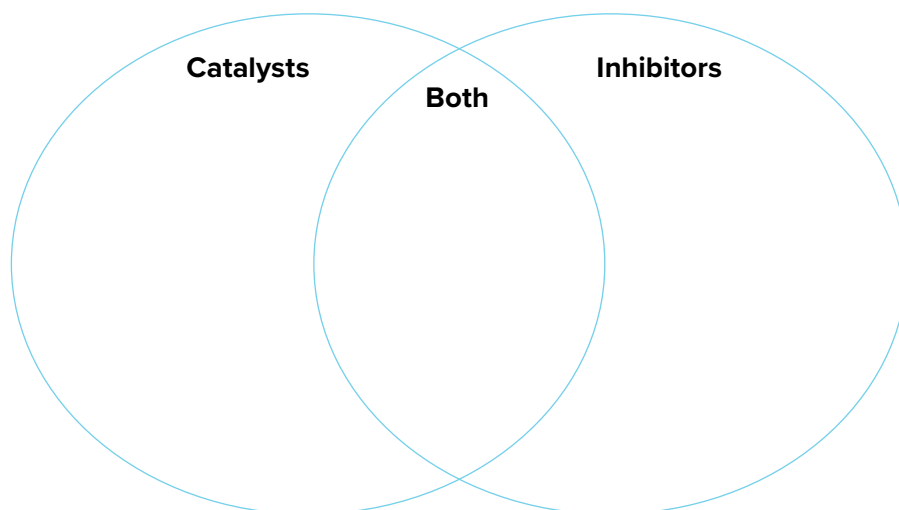
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**Organize** information about the roles of catalysts and inhibitors in chemical reactions. Fill in the Venn diagram with examples and phrases from the list below.

speed up reactions  
slow down reactions  
not used up in the reaction  
food preservatives

enzymes in the body  
used in auto industry  
used to make polymers



## 4 Reaction Rates and Equilibrium (continued)

**Get It?** **Contrast** the forward and reverse reactions in a reversible reaction.

**List** the reactants and products of the following reversible reaction.

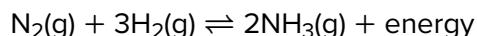


	Reactant(s)	Product(s)
Forward reaction		
Reverse reaction		

**Complete** the following statement.

The state in which forward and reverse reactions balance each other because they take place at equal \_\_\_\_\_ is called \_\_\_\_\_. For a chemical reaction in equilibrium, the net amounts of reactants and products remain \_\_\_\_\_.

**Determine** how each of the following stresses will affect the equilibrium of the Haber process, shown in the equation below. Place an X in the appropriate column of the table for each stress.



Stress	Shifts equilibrium left	Shifts equilibrium right
Decrease concentration of $\text{NH}_3$ by removing $\text{NH}_3$ as it forms		
Decrease volume/increase pressure		
Increase temperature		

## 4 Reaction Rates and Equilibrium (continued)

### CHECK YOUR PROGRESS

**26. List** four ways to change the rate of a chemical reaction.

---

---

**27. Describe** two ways in which you might state the rate of a chemical reaction.

---

**28. Explain** what must happen in order for two molecules to react.

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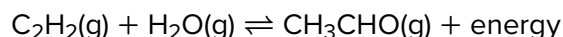
**29. Compare and contrast** chemical and physical equilibrium.

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**30. Apply** Describe two ways you could influence the following equilibrium to produce more ethanal ( $\text{CH}_3\text{CHO}$ ). Use Le Châtelier's principle to explain why each of your methods would produce the desired result.



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**31. Math Connection** For the reaction described in question 30, the concentration of  $\text{CH}_3\text{CHO}$  is found to increase from 0.0300 mol/L to 0.0500 mol/L in 42.5 seconds. Express the average rate of the reaction in mol  $\text{CH}_3\text{CHO}$  produced/L·s.

---



# 20 Radioactivity and Nuclear Reactions

## ENCOUNTER THE PHENOMENON

Write the Encounter the Phenomenon question for this module.

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---

Use the “What I Know” column to list the things you know about the Encounter the Phenomenon question. Then list the questions you have about the Encounter the Phenomenon question in the “What I Want to Find Out” column. As you read the module, fill in the “What I Learned” column.

K <i>What I Know</i>	W <i>What I Want to Find Out</i>	L <i>What I Learned</i>

# Radioactivity and Nuclear Reactions

## 1 The Nucleus

### REVIEW VOCABULARY

electric force

Recall the definition of the Review Vocabulary term.

electric force

### NEW VOCABULARY

strong force

radioactivity

Use your book to define each term.

strong force

radioactivity

## 1 The Nucleus (continued)

**Describe** the nucleus. Discuss its size and what makes it up.

---

---

---

**Get It? Define** atomic number.

---

---

---

**Get It? Identify** the force that produces the attraction between protons and neutrons.

---

---

**Get It? Compare** the strong force between two protons that are very close together with the electromagnetic force between the same two protons.

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---

## 1 The Nucleus (continued)

**Compare and contrast** the strong force and the electrical force in the nuclei of atoms. Describe each force for a small and a large nucleus.

Nucleus Size	Strong Force	Electrical Force	Comparison: Total Effect
small			
large			

**Get It? Explain** why, in a large nucleus, the strong force holding a proton in place is about the same as for a small nucleus but the electric force on the proton is greater.

---

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## 1 The Nucleus (continued)

**Organize** important information about radioactivity in the boxes below.

**Isotopes**

**Nucleus Stability**

**Radioactivity**

**Element Symbols**

## 1 The Nucleus (continued)

### CHECK YOUR PROGRESS

1. **Compare** the properties of the strong force to the properties of the electromagnetic force.

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2. **Compare** the forces in a small nucleus to the forces in a large nucleus.

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3. **Explain** why large nuclei tend to be radioactive.

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4. **Explain** whether you would expect helium-6 to be radioactive or stable.

---

---

5. **Math Connection** What is the approximate ratio of neutrons to protons in a nucleus of radon-222?

---

---

# Radioactivity and Nuclear Reactions

## 2 Nuclear Decays and Reactions

### REVIEW VOCABULARY

gamma ray

Recall the definition of the Review Vocabulary term.

gamma ray

### NEW VOCABULARY

alpha particle

beta particle

transmutation

chain reaction

Use your book to define each term.

alpha particle

beta particle

transmutation

chain reaction

## 2 Nuclear Decays and Reactions (continued)

Nuclear Radiation			
	Alpha	Beta	Gamma
Symbol			$\gamma$
Composition			
Cause		weak force causes a neutron to decay into a proton plus a beta particle	
Charge			none
Mass	extremely massive compared with other radiations		
Speed		faster than alpha	
Penetration			
Can be stopped by...	sheet of paper		



## 2 Nuclear Decays and Reactions (continued)

**Get It? Identify** the components of an alpha particle.

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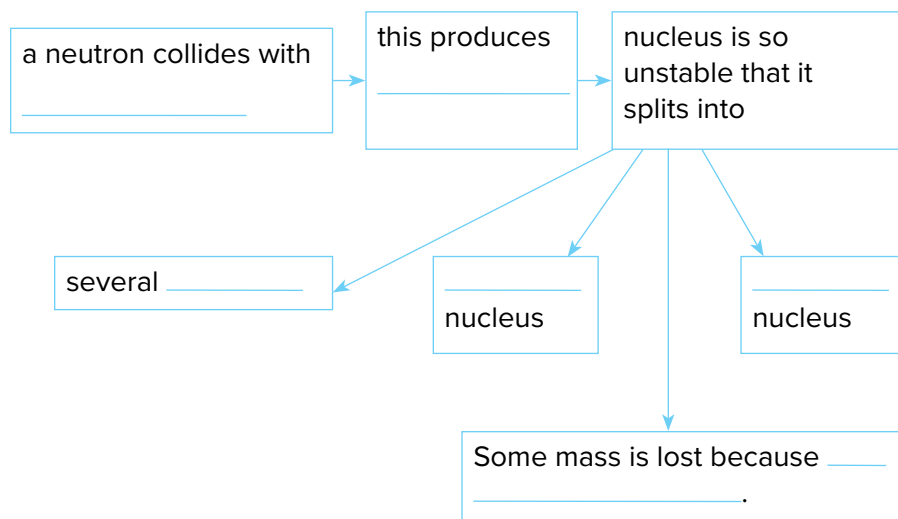
**Get It? Identify** the changes in the nucleus that result from transmutation caused by alpha decay and explain how they affect the total number of protons and neutrons.

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---

**Summarize** the process of nuclear fission of uranium.



**Get It? Explain** why the extremely high temperatures found in the centers of stars are needed for fusion to occur in stars.

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## 2 Nuclear Decays and Reactions (continued)

**Get It? Compare** the masses before and after a nuclear fusion reaction.

---

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---

**Summarize** the energy requirements of nuclear fusion.

what must be overcome: \_\_\_\_\_

this is in order to: \_\_\_\_\_

type of energy that can do it: \_\_\_\_\_

this type of energy increases with: \_\_\_\_\_

common places to find enough energy: \_\_\_\_\_

---

**Define** Einstein's mass-energy equation in words and then write the formula.

**Words:** \_\_\_\_\_ (joules) = \_\_\_\_\_ (kg) [ \_\_\_\_\_ (m/s)] \_\_\_\_\_

**Formula:** \_\_\_\_\_

**Get It? Explain** why the mass-energy relationship can be observed in nuclear changes but not in chemical changes.

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## 2 Nuclear Decays and Reactions (continued)

### CHECK YOUR PROGRESS

8. **Contrast** the energy that can be released during a nuclear fission reaction with the energy that can be released during a nuclear fusion reaction.

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9. **Contrast** alpha particles, beta particles, and gamma rays.

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10. **Explain** why mass-energy equivalence is not apparent for chemical reactions.

---

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11. **Explain** why high temperatures are needed for fusion reactions to occur but not for fission reactions to occur.

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12. **Math Connection** In a chain reaction, two additional fissions occur for each nucleus that is split. If one nucleus is split in the first step of the reaction, how many nuclei will have been split after the fifth step?

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# Radioactivity and Nuclear Reactions

## 3 Radiation Technologies and Applications

### REVIEW VOCABULARY

electric current

Recall the definition of the Review Vocabulary term.

*electric current*

### NEW VOCABULARY

tracer

half-life

Use your book to define each term.

*tracer*

*half-life*

### 3 Radiation Technologies and Applications (continued)

**Describe** how a Geiger counter works to detect or measure radiation.

Geiger Counter: \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

**Sequence** the sources of background radiation that occur in nature. Order them from greatest percentage to least percentage.

Background Radiation	
Source	Percent of Total Radiation
Inside the body	
	11%
Rocks and soil	

**Get It?** **Describe** a medical use for iodine-131.

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

**Identify** four facts about background radiation absorbed by the body.

1. \_\_\_\_\_

2. \_\_\_\_\_

3. \_\_\_\_\_

4. \_\_\_\_\_

### 3 Radiation Technologies and Applications (continued)

**Get It?** Define *half-life*.

---

---

---

**Get It?** Define *daughter nucleus*.

---

---

---

**Get It?** Identify how many of the original parent nuclei remain after three half-lives.

---

---

---

**Complete** the table to illustrate the half-life of a radioactive isotope.

Number of Half-lives	Fraction of Parent Nuclei Remaining	Fraction of Daughter Nuclei Formed
0	1	0
1		
2		
3		

### 3 Radiation Technologies and Applications (continued)

#### CHECK YOUR PROGRESS

- 13. Explain** how half-life would help determine which isotopes might be useful for a medical test.

---

---

---

---

- 14. Describe** what happens when beta particles pass through a Geiger counter.

---

---

- 15. Explain** why background radiation can never be completely eliminated.

---

---

- 16. Explain** Why is an archeologist unable to use carbon-14 to accurately date the age of a skeleton that is millions of years old?

---

---

- 17. Math Connection** What is the percentage of radioactive nuclei left after 3 half-lives pass?

---

---

- 18. Math Connection** If the half-life of iodine-131 is 8 days, how much of a 5.0-g sample is left after 32 days?

---

---





# 21 Solutions

## ENCOUNTER THE PHENOMENON

Write the Encounter the Phenomenon question for this module.

Use the “What I Know” column to list the things you know about the Encounter the Phenomenon question. Then list the questions you have about the Encounter the Phenomenon question in the “What I Want to Find Out” column. As you read the module, fill in the “What I Learned” column.

K <i>What I Know</i>	W <i>What I Want to Find Out</i>	L <i>What I Learned</i>

# Solutions

## 1 How Solutions Form

### REVIEW VOCABULARY

polar molecule

Recall the definition of the Review Vocabulary term.

polar molecule

### NEW VOCABULARY

alloy

solute

solvent

Use your book to define each term.

alloy

solute

solvent

## 1 How Solutions Form (continued)

**Create** an example of a gas, liquid, and solid phase of a solution in the boxes below. Label the solute and solvent in each box. Use the figures in your book for help.

--	--	--

**Sequence** a three-step process of dissolving a polar solid in a polar liquid.

**Step 1.**




**Step 2.**




**Step 3.**


**Get It? Explain** How do you know which substance is the solute in a solution?


## 1 How Solutions Form (continued)

**Define** one characteristic of dissolving a gas in a liquid and one unique characteristic of dissolving a solid in a solid.

Dissolving gas in a liquid: \_\_\_\_\_

\_\_\_\_\_

Dissolving a solid in a solid: \_\_\_\_\_

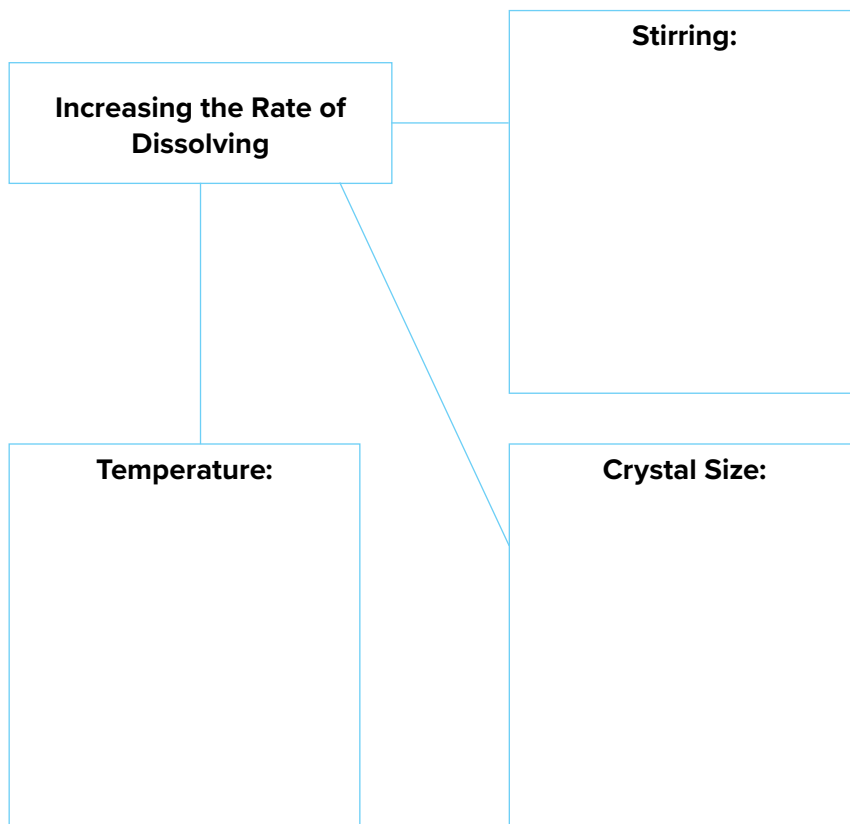
\_\_\_\_\_

**Get It? Identify** where a solid actually dissolves when placed in a liquid.

\_\_\_\_\_

\_\_\_\_\_

**Organize** how crystal size, stirring, and temperature are used to speed up the rate of dissolving.



## 1 How Solutions Form (continued)

### CHECK YOUR PROGRESS

4. **Summarize** possible ways in which phases of matter could combine to form a solution.

---

---

5. **Draw** a diagram that shows how a solid dissolves in a liquid.

---

---

---

6. **Describe** how stirring, surface area, and temperature affect the rate of dissolving.

---

---

---

---

7. **Explain** Amalgams are sometimes used in tooth fillings and are made of mercury. Explain why an amalgam is a solution.

---

---

---

---

8. **Math Connection** Calculate the surface area of a rectangular solid with dimensions  $l = 2$  cm,  $w = 1$  cm, and  $h = 0.5$  cm.

---

---

9. **Math Connection** If the length of the rectangle in question 8 is increased by 10%, by what percentage will the surface increase?

---

---

# Solutions

## 2 Concentration and Solubility

### REVIEW VOCABULARY

solution

Recall the definition of the Review Vocabulary term.

solution

### NEW VOCABULARY

concentration

saturated solution

solubility

supersaturated solution

unsaturated solution

Use your book to define each term.

concentration

saturated solution

solubility

supersaturated solution

unsaturated solution

## 2 Concentration and Solubility (continued)

**Get It? Explain** What is solubility?

---

---

**Identify** four items that you might buy in concentrated form but would dilute before using them. Accept all reasonable responses.

1. 

---
2. 

---
3. 

---
4. 

---

**Synthesize** Suppose you and a friend are making iced tea using identical glasses. You both use the same amount of water, and the water temperature is the same in both glasses. Explain how you can tell who added more ice tea mix to the glass.

---

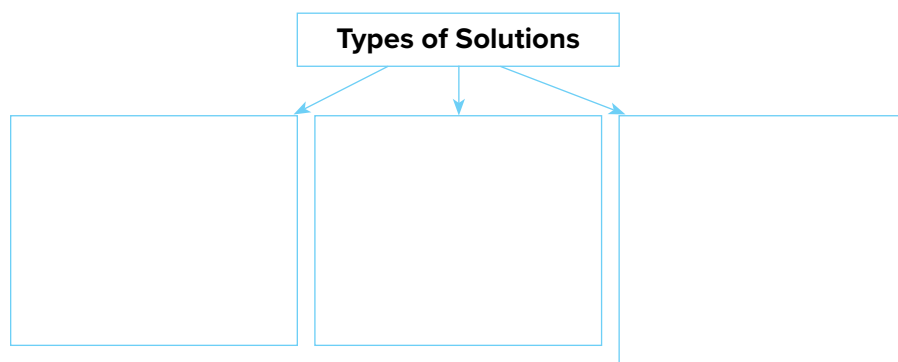
---

**Get It? Explain** how the temperature of a liquid solvent affects the solubility of a compound.

---

---

**Organize** Name and define the three types of solutions discussed in your book.



## 2 Concentration and Solubility (continued)

**Analyze** the graph titled Temperature Effects on Solubility in your book. Then list the four substances from least soluble to most soluble at 70°C.

1. \_\_\_\_\_
2. \_\_\_\_\_
3. \_\_\_\_\_
4. \_\_\_\_\_

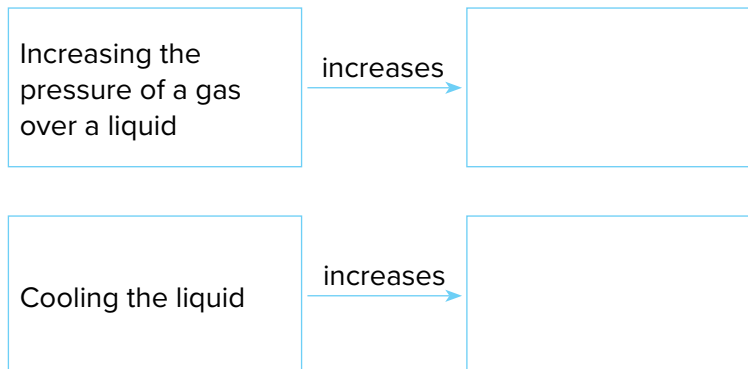
**Get It?** **Explain** why the term *unsaturated* is not a precise term.

---

---

---

**Complete** the graphic organizer about the solubility of gases.



**Evaluate** why many people prefer to store carbonated beverages in the refrigerator.

---

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---



## 2 Concentration and Solubility (continued)

### CHECK YOUR PROGRESS

**10. Contrast** What is the difference between solubility and concentration?

---

---

---

**11. Compare and contrast** the difference between relative and precise concentrations. Give examples.

---

---

---

---

**12. Explain** Do all solutes dissolve to the same extent in the same solvent? How do you know?

---

**13. Identify** the type of solution that you have if solute continues to dissolve as you add more.

---

**14. Explain** how keeping a carbonated beverage capped and refrigerated helps keep it from going flat.

---

---

**15. Math Connection** By volume, orange drink is ten percent each of orange juice and corn syrup. A 1.5-L can of the drink costs \$0.05. A 1.5-L can of orange juice is \$1.49, and 1.5 L of corn syrup is \$1.69. Per serving, does it cost less to make your own orange drink or to buy it?

---

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---

# Solutions

## 3 Particles in Solution

### REVIEW VOCABULARY

ion

Recall the definition of the Review Vocabulary term.

substance

### VOCABULARY

dissociation

electrolyte

ionization

nonelectrolyte

Use your book to define each term.

dissociation

electrolyte

ionization

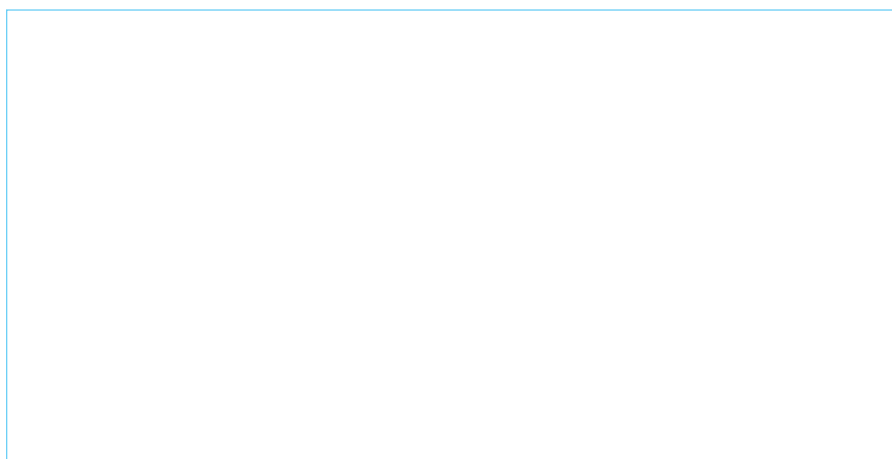
nonelectrolyte

### 3 Particles in Solution (continued)

**Complete** the table by describing the current that can be conducted by each type of solution. Give an example for each.

Type	Description of Current	Example
strong electrolytes		
weak electrolytes		
nonelectrolytes		

**Model** the ionization process of hydrogen chloride, as shown in your book. Label the positive ion and negative ions in your drawing.



**Get It? Name** the two ways that solutions of electrolytes form.

---

---

**Summarize** in your own words how ionic solutions form.

Ionization: \_\_\_\_\_

---

---

Dissociation: \_\_\_\_\_

---

---

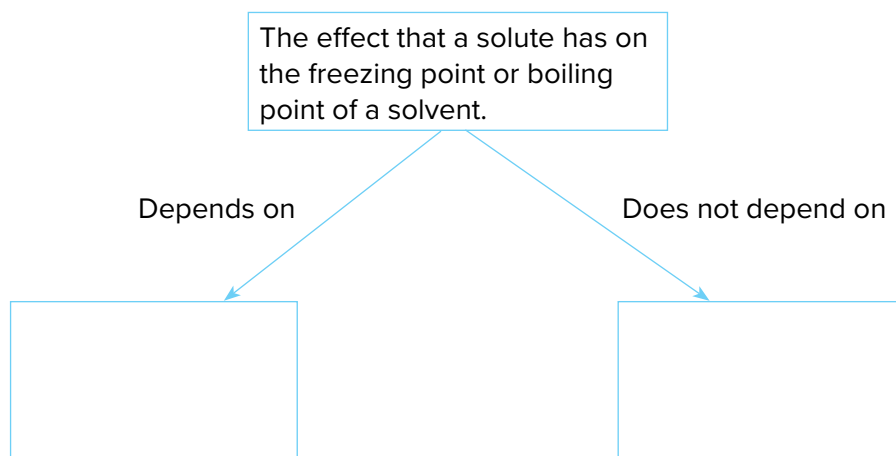
### 3 Particles in Solution (continued)

**Get It? Compare and Contrast** What are the differences and similarities between dissociation and ionization?

---

---

**Organize** the effects of solute particles by completing the organizer.



**Get It? Describe** How does antifreeze affect the vapor pressure of a pure solvent?

---

---

---

**Synthesize** why antifreeze is important to a car's radiator in both the summer and in the winter.

---

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---

---

---

---

### 3 Particles in Solution (continued)

#### CHECK YOUR PROGRESS

- 16. Explain** how the concentration of a solute in a solution influences its boiling point and freezing point.

---

---

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---

- 17. Identify** what kinds of solute particles are present in water solutions of electrolytes and nonelectrolytes.

---

- 18. Determine** whether ionization or dissociation has taken place if calcium phosphate ( $\text{Ca}_3(\text{PO}_4)_2$ ) breaks into  $\text{Ca}^{2+}$  and  $\text{PO}_4^{3-}$ .

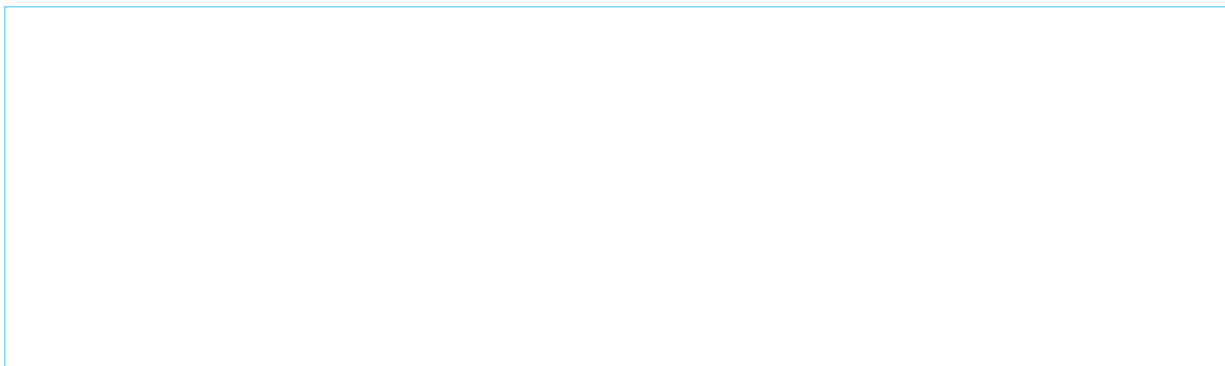
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- 19. Explain** People often put salt on ice that forms on sidewalks and driveways during the wintertime. The salt helps melt the ice, forming a saltwater solution. Explain why this solution resists refreezing.

---

---

- 20. Math Connection** Use the data points (0, 12), (10, 8), (20, 4), and (30, 0) to graph the effect of a solute on the freezing point of a solvent. Label the *x-axis Solute (g)* and the *y-axis Freezing point (degrees Celsius)*. Find the slope of the line that you graph.



# Solutions

## 4 Dissolving Without Water

### REVIEW VOCABULARY

polar molecule

Recall the definition of the Review Vocabulary term.

*polar molecule*

---

---

---

## 4 Dissolving Without Water (continued)

**Describe** Fill in the blanks to describe nonpolar solutes.

The molecules have no separate positive and negative areas, so they are not attracted to \_\_\_\_\_ water molecules and do not \_\_\_\_\_ in water.

**Classify** four nonpolar materials you may find around your home

1. \_\_\_\_\_
2. \_\_\_\_\_
3. \_\_\_\_\_
4. \_\_\_\_\_

**Summarize** information about useful nonpolar molecules.

### I. Drawbacks of Nonpolar Solvents

- A. \_\_\_\_\_ B. \_\_\_\_\_

### II. How Soap Works

- A. \_\_\_\_\_  
\_\_\_\_\_  
B. \_\_\_\_\_  
\_\_\_\_\_  
C. \_\_\_\_\_  
\_\_\_\_\_

**Get It? Summarize** Why is soap required to clean oily dirt?

\_\_\_\_\_

**Classify** Vitamins A, B, C, D, E, and K as being either fat soluble or water soluble.

Fat soluble: \_\_\_\_\_

Water soluble: \_\_\_\_\_

**Get It? Restate** Why is it necessary to replace water-soluble vitamins more quickly than fat-soluble vitamins?

\_\_\_\_\_  
\_\_\_\_\_

## 4 Dissolving Without Water (continued)

### CHECK YOUR PROGRESS

- 21. Explain** how a polar solvent dissolves a polar solute and how a nonpolar solvent dissolves a nonpolar solute.

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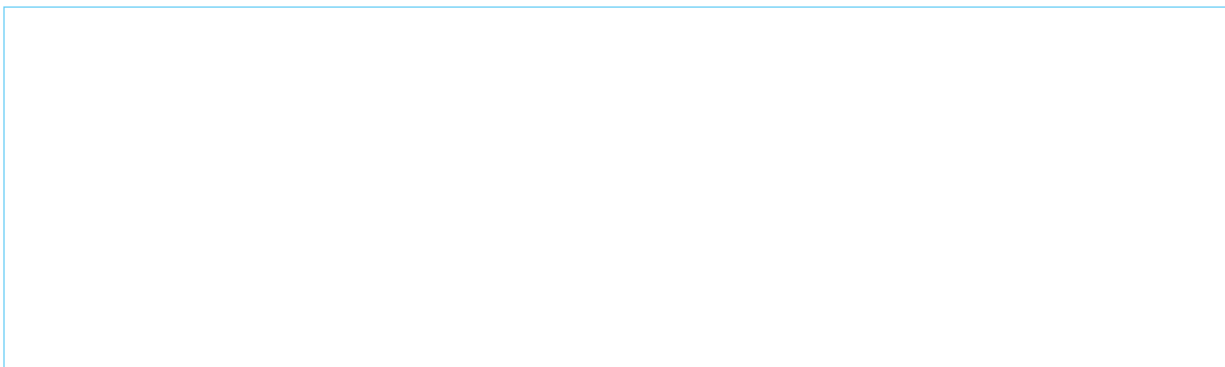
- 22. Describe** polar and nonpolar molecules.

---

- 23. Explain** how one solute can dissolve in both polar and nonpolar solvents.

---

- 24. Draw** a diagram to explain how soap cleans your hands.



- 25. Describe** What might happen to your skin if you washed too often?

---

---

- 26. Math Connection** If 60 mg of vitamin C in a multivitamin provides only 75 percent of the recommended daily dosage for children, how much is recommended?

---

- 27. Math Connection** To get the recommended dose of vitamin C, approximately how much fresh orange juice must you drink? (Refer to Table 3 in your book)

---



# 22 Acids, Bases, and Salts

## ENCOUNTER THE PHENOMENON

Write the Encounter the Phenomenon question for this module.

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Use the “What I Know” column to list the things you know about the Encounter the Phenomenon question. Then list the questions you have about the Encounter the Phenomenon question in the “What I Want to Find Out” column. As you read the module, fill in the “What I Learned” column.

K <i>What I Know</i>	W <i>What I Want to Find Out</i>	L <i>What I Learned</i>

# Acids, Bases, and Salts

## 1 Acids and Bases

### REVIEW VOCABULARY

electrolyte

Recall the definition of the Review Vocabulary term.

electrolyte

### NEW VOCABULARY

acid

hydronium ion

indicator

hydroxide ion

base

Use your book to define each term.

acid

hydronium ion

indicator

hydroxide ion

base

## 1 Acids and Bases (continued)

**Organize** information about acids using the table below.

Acids	
Definition:	Four Common Properties:
Four Common Acids:	Four Uses of Acids:

**Get It? Name** four acids that are important for industry.

---

---

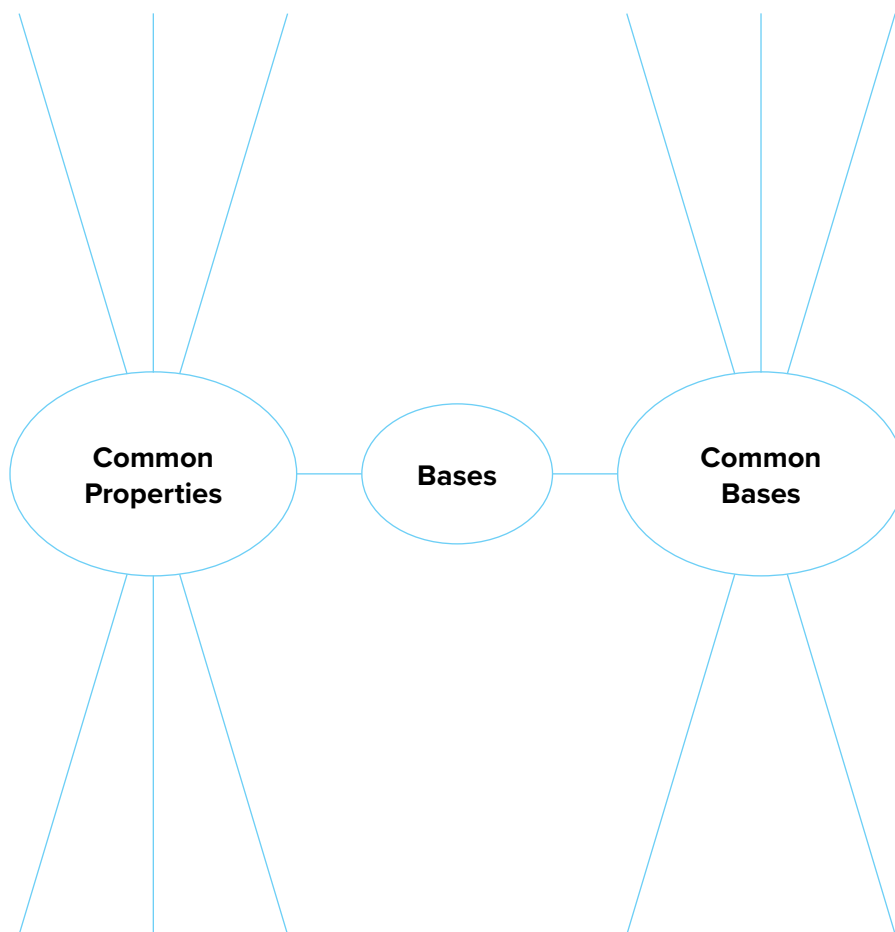
**Get It? Describe** how hydrogen ions are associated with both acids and bases.

---

---

## 1 Acids and Bases (continued)

**Identify** a fact or example about bases on each line.



**Create** one review question dealing with the ionization of acids and one review question dealing with the dissociation of bases. Give answers to your two questions.

1. Question: \_\_\_\_\_

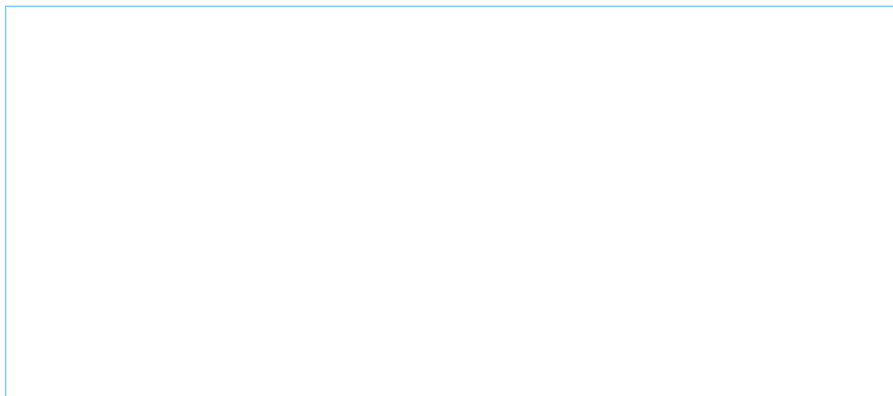
Answer: \_\_\_\_\_

2. Question: \_\_\_\_\_

Answer: \_\_\_\_\_

## 1 Acids and Bases (continued)

**Model** an ammonia molecule and a water molecule. Show what happens during dissociation.



**Get It?** **Explain** how ammonia reacts in a water solution.

---

**Analyze** how ammonia can be a base even though it does not contain  $\text{OH}^-$ .

---

---

---

---

## 1 Acids and Bases (continued)

### CHECK YOUR PROGRESS

1. **Describe** how an acidic solution forms when HCl is mixed in water and how a basic solution forms when NaOH is mixed in water.

---

---

---

2. **Explain** what an indicator is.

---

---

3. **Write** the formulas of three important acids and three important bases and describe their uses.

---

---

---

---

4. **Compare and contrast** how  $\text{NH}_3$  and  $\text{Ca}(\text{OH})_2$  form  $\text{OH}^-$  ions in water.

---

---

5. **Apply** A friend asks you to get something from the kitchen, but he uses chemical formulas to ask for it. He asks for a drink which does not contain  $\text{H}_2\text{CO}_3$ , but does have  $\text{H}_2\text{C}_6\text{H}_6\text{O}_6$ . What might he be asking for?

---

---

---

6. **Math Connection** Calculate the molecular mass of acetylsalicylic acid ( $\text{HOOC-C}_6\text{H}_4\text{-OOCCH}_3$ ).

---

---

# Acids, Bases, and Salts

## 2 Strength of Acids and Bases

### REVIEW VOCABULARY

ionization

Recall the definition of the Review Vocabulary term.

ionization

### NEW VOCABULARY

strong acid

weak acid

strong base

weak base

pH

buffer

Use your book to define each term.

strong acid

weak acid

strong base

weak base

pH

buffer

## 2 Strength of Acids and Bases (continued)

**Analyze** information about strong and weak acids and bases.

	Equation for Dissociation	Arrow Directions Demonstrate
Weak acid		
Weak base		
Strong acid		
Strong base		

**Evaluate** why acids are able to conduct electricity. Then describe which types of acids are better conductors and why.

---



---



---



---

**Contrast** the terms *weak* and *dilute* as they describe acids and bases.

Weak	Dilute



## 2 Strength of Acids and Bases (continued)

**Describe** what the particles of an acid or base would look like with each combination of characteristics listed below.

	Concentrated	Dilute
Weak	There are many particles, but not all are dissociated ions.	
Strong		

**Model** a pH scale from 0 to 14. Then complete the following:

- Circle and label a neutral pH.
- Use arrows to show which direction indicates more acidic and which direction indicates more basic.
- Circle and label the pH level with the highest concentration of  $H^+$  ions and the pH level with the lowest concentration of  $H^+$  ions.

**Analyze** how buffers allow you to eat acidic and basic foods without changing your blood pH.

**Get It? Explain** what buffers are and how they are important for health.

## 2 Strength of Acids and Bases (continued)

### CHECK YOUR PROGRESS

7. **Compare and contrast** a dilute solution of a strong acid and a concentrated solution of a weak acid.

---

---

---

8. **Describe** two techniques used to measure the pH of a solution.

---

---

9. **Explain** how electricity can be conducted by acids and bases.

---

---

10. **Relate** pH values of 9.1, 1.2, and 5.7 to hydronium and hydroxide ion concentration and characterize each as basic, acidic, or very acidic.

---

---

11. **Explain** The proper pH range for a swimming pool is between 7.2 and 7.8. Most pools use two substances,  $\text{Na}_2\text{CO}_3$  and  $\text{HCl}$ , to maintain this range. How would you adjust the pH if you found it was 8.2? 6.9?

---

---

---

12. **Math Connection** To determine the difference in pH strength, calculate  $10^n$ , where  $n$  is the difference between pHs. How much more acidic is a solution of pH 2.4 than a solution of pH 4.4?

---

# Acids, Bases, and Salts

## 3 Salts

### REVIEW VOCABULARY

nonpolar molecule

Recall the definition of the Review Vocabulary term.

nonpolar molecule

### NEW VOCABULARY

neutralization

salt

titration

soap

Use your book to define each term.

neutralization

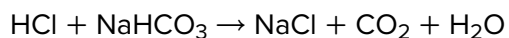
salt

titration

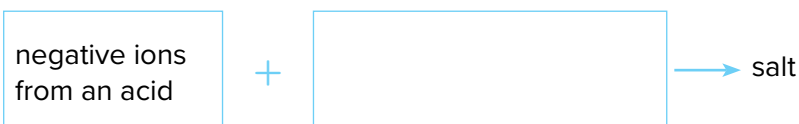
soap

### 3 Salts (continued)

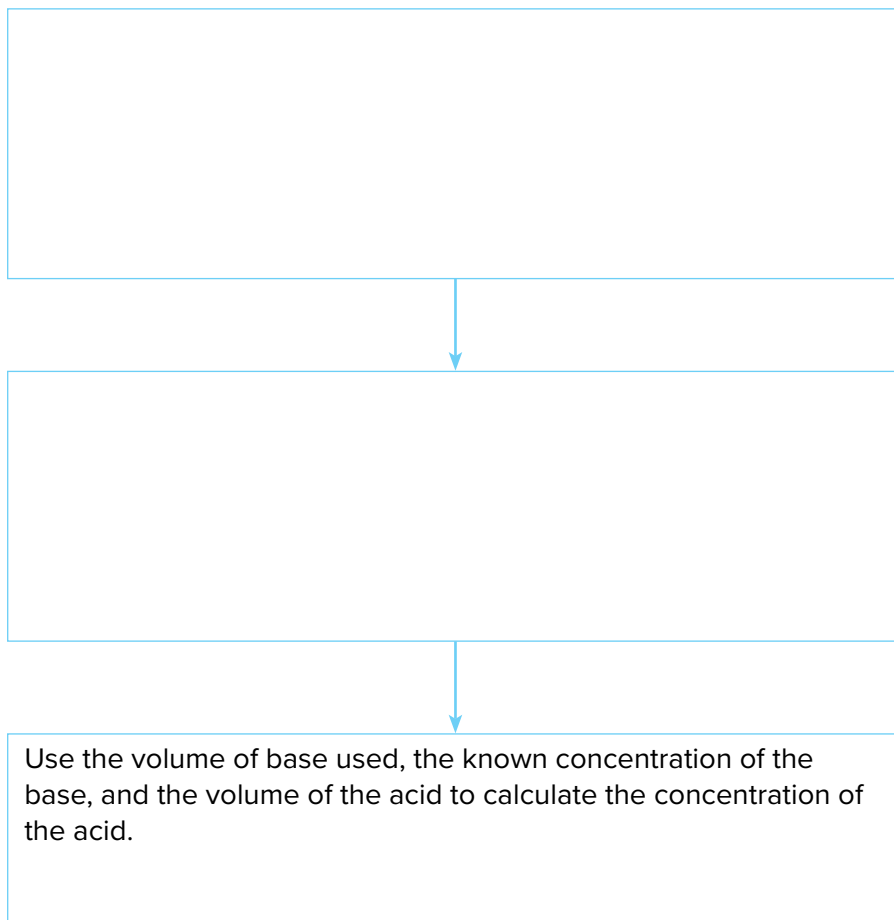
**Identify** the acid, base, salt, and water in the neutralization reaction below.



**Complete** the graphic organizer describing the formation of a salt.



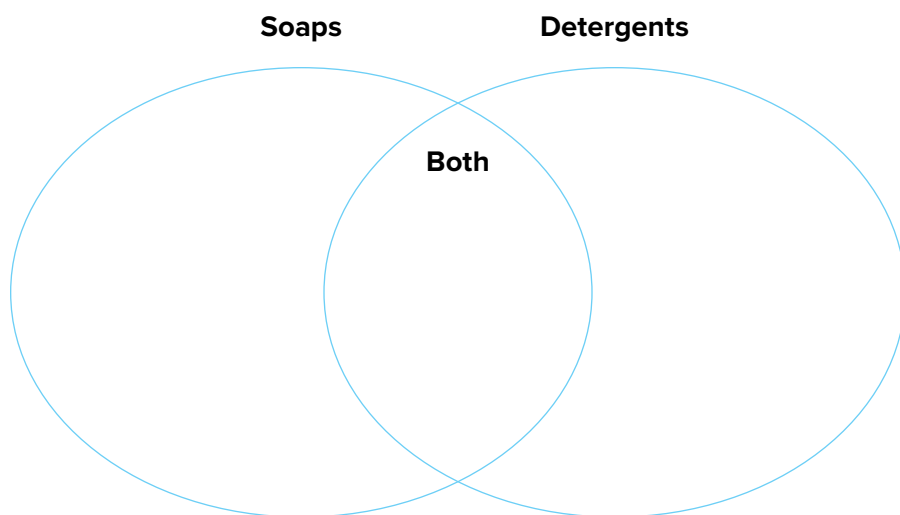
**Sequence** the steps used to find the concentration of an acid solution by titration. The last step has been completed for you.



### 3 Salts (continued)

**Compare and contrast** characteristics of soaps and detergents in the Venn diagram below.

- contain a sulfonic acid group
- have carboxylic acid group
- have long hydrocarbon chains
- insoluble in hard water
- may cause excess foam
- used for cleaning
- make soap scum



**Get It?** Explain why soaps must have polar and nonpolar ends.

---

---

---

---

### 3 Salts (continued)

**Get It? Explain** What is soap scum?

---

---

---

**Explain** the relationship between detergents, soap scum, and hard water.

---

---

---

**Design** a simple experiment to show how neutralization works using a natural indicator with a kitchen acid and a kitchen base.

---

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### 3 Salts (continued)

#### CHECK YOUR PROGRESS

- 13. Write** the balanced chemical equation for one neutralization reaction. In your equation, which reactant contributed the salt's positive ion? Which one contributed the salt's negative ion?

---

---

---

- 14. Identify** the purpose of an indicator in a titration experiment.

---

---

- 15. Compare and contrast** the composition of detergents and soaps.

---

---

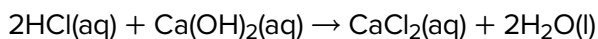
- 16. Predict** Give the names and formulas of the salts formed in the following neutralizations: sulfuric acid and calcium hydroxide, nitric acid and potassium hydroxide, and carbonic acid and aluminum hydroxide.

---

---

---

- 17. Math Connection** In the following reaction, how many molecules of HCl are needed to produce four molecules of H<sub>2</sub>O?



---

---





# 23 Organic Compounds

## ENCOUNTER THE PHENOMENON

Write the Encounter the Phenomenon question for this module.

---

---

---

Use the “What I Know” column to list the things you know about the Encounter the Phenomenon question. Then list the questions you have about the Encounter the Phenomenon question in the “What I Want to Find Out” column. As you read the module, fill in the “What I Learned” column.

<b>K</b> <i>What I Know</i>	<b>W</b> <i>What I Want to Find Out</i>	<b>L</b> <i>What I Learned</i>

# Organic Compounds

## 1 Simple Organic Compounds

### REVIEW VOCABULARY

covalent bond

Recall the definition of the Review Vocabulary term.

*covalent bond*

### VOCABULARY

organic compound

hydrocarbon

saturated hydrocarbon

unsaturated hydrocarbon

isomers

benzene

Use your book to define each term.

*organic compound*

*hydrocarbon*

*saturated hydrocarbon*

*unsaturated hydrocarbon*

*isomers*

*benzene*

## 1 Simple Organic Compounds (continued)

**Compare** organic and inorganic compounds. Give examples of each type.

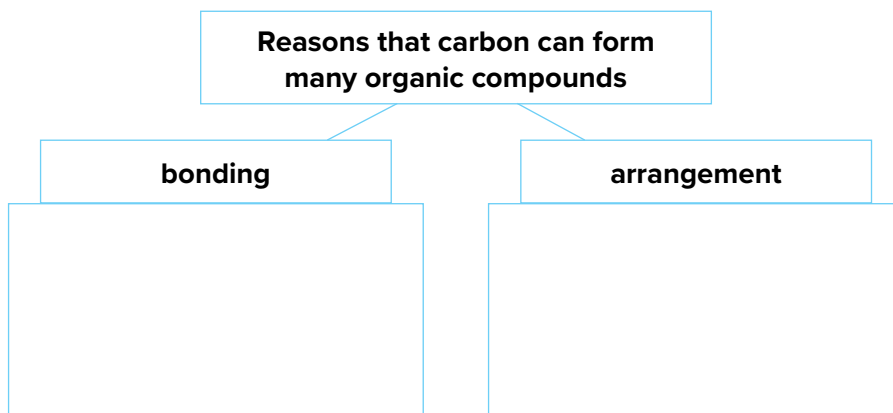
Organic	Inorganic

**Get It? Explain** why the element carbon can form so many different organic compounds.

---

---

**Complete** the concept map by describing how carbon can form so many organic compounds through bonding and arrangement.



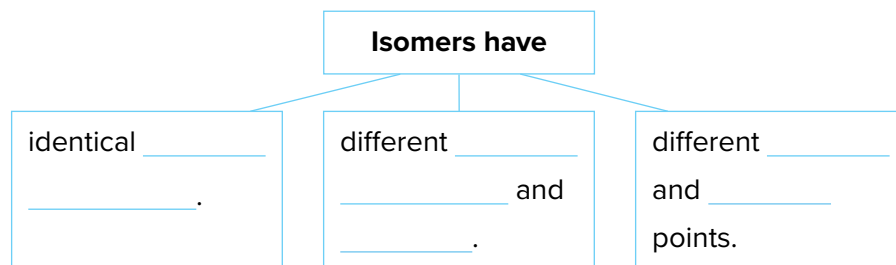
**Get It? State** the number of carbon atoms and hydrogen atoms in each molecule in **Figure 4** (in your textbook).

---

## 1 Simple Organic Compounds (continued)

**Create** Draw the structural formula for one of the hydrocarbons in this section. Name the hydrocarbon and explain why it is a hydrocarbon on the lines below.

**Complete** the graphic organizer about isomers.



**Get It? Explain** why propane and cyclopropane are not isomers, even though both have three carbon atoms and neither has double or triple bonds.

**Identify** the type or types of bonds between the carbon atoms in each hydrocarbon. Make a sketch of each molecule. Then categorize each hydrocarbon as saturated or unsaturated.

Hydrocarbon	Type(s) of Bond	Sketch	Saturated or Unsaturated
Ethene			
Ethyne			
Propane			
Propene			

## 1 Simple Organic Compounds (continued)

### CHECK YOUR PROGRESS

1. **Define** the term *organic compounds* and explain how they got this name.

---

---

---

2. **Classify** each of the following compounds as organic or inorganic:  $C_4H_{10}$ ,  $H_2O$ ,  $FeO$ ,  $CH_3COOH$ , and  $CaS$ .

---

---

3. **Compare and contrast** ethane, ethene, and ethyne.

---

---

---

4. **Explain** the term *saturated* in relation to hydrocarbons. What are these compounds saturated with?

---

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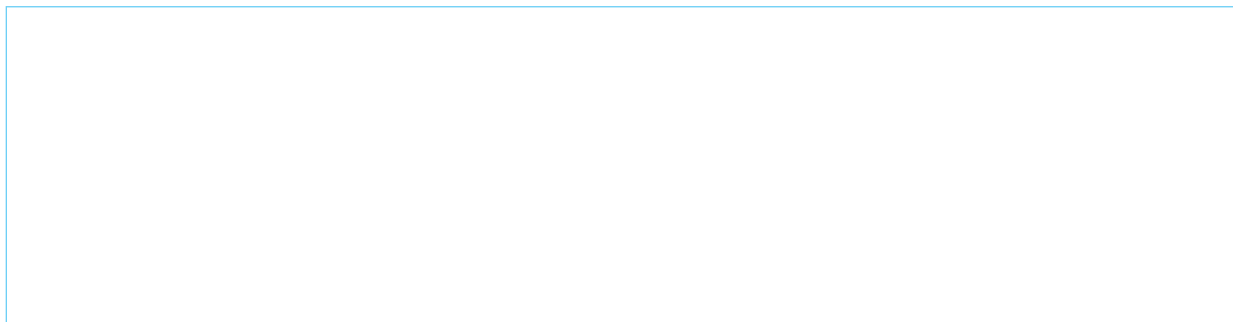
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## 1 Simple Organic Compounds (continued)

### CHECK YOUR PROGRESS

5. **Describe** how boiling and melting points generally vary as branching in hydrocarbon isomers increases.

6. **Analyze** Cyclobutane is a cyclic, saturated hydrocarbon containing four carbon atoms. Draw its structural formula. Are cyclobutane and butane isomers? Explain.



7. **Math Connection** Adding one double bond to octane ( $C_8H_{18}$ ) makes the hydrocarbon octene ( $C_8H_{16}$ ). Write the formulas for adding one, two, and three more double bonds to octane. What is the decrease in the number of hydrogen atoms for each double bond added?

# Organic Compounds

## 2 Substituted Hydrocarbons

### REVIEW VOCABULARY

acid

Recall the definition of the Review Vocabulary term.

*acid*

### VOCABULARY

substituted hydrocarbon

alcohol

ester

amine

aromatic compound

Use your book to define each term.

*substituted hydrocarbon*

*alcohol*

*ester*

*amine*

*aromatic compound*

## 2 Substituted Hydrocarbons (continued)

**List** two ways that chemists can change hydrocarbons into other compounds.

1. \_\_\_\_\_
2. \_\_\_\_\_  
\_\_\_\_\_

**Compare** substituted hydrocarbons using the table below.

	How are they formed?	Examples
Alcohols		
Organic Acids		
Esters		
Amines		

**Get It? Explain** why organic acids are considered substituted hydrocarbons.

\_\_\_\_\_

**Identify** five elements other than carbon, hydrogen, and oxygen that can be added to hydrocarbons.

1. \_\_\_\_\_
2. \_\_\_\_\_
3. \_\_\_\_\_
4. \_\_\_\_\_
5. \_\_\_\_\_



## 2 Substituted Hydrocarbons (continued)

**Model** the structural formula for the ester of your choice. Use the figures in your book to help you. Use a highlighter to identify the  $\text{-COOC-}$  group. Write the name and chemical formula for the ester, too.

**Complete** the table about aromatic compounds.

Definition	Properties
Structure found in all aromatic compounds	Examples

**Summarize** Write a journal entry about some organic compounds you use. Identify at least one aromatic compound, one alcohol, and one acid.

## 2 Substituted Hydrocarbons (continued)

### CHECK YOUR PROGRESS

8. **Classify** each of the following as a hydrocarbon or a substituted hydrocarbon: ethyne, tetrachloroethene, ethanol, benzene, propane, and acetic acid.

---

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9. **Identify** the structure that is present in all aromatic compounds.

---

10. **Explain** why chemists might want to prepare substituted hydrocarbons. Give two examples of possible substitutions.

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11. **Identify** possible uses for each of the following types of substituted hydrocarbons: alcohols, esters, and halocarbons.

---

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12. **Explain** Chloroethane ( $C_2H_5Cl$ ) can be used as a spray-on anesthetic for localized injuries. How does chloroethane fit the definition of a substituted hydrocarbon? Diagram its structure.

13. **Math Connection** The odor of mercaptans can be detected in concentrations as low as 0.5 parts per million. Express this concentration as a percent.

---

# Organic Compounds

## 3 Petroleum—A Source of Organic Compounds

### REVIEW VOCABULARY

condense

Recall the definition of the Review Vocabulary term.

*condense*

### VOCABULARY

Write the correct vocabulary term in the left column for each definition below.

a small molecule that forms a link in a polymer chain

a very large molecule made from small molecules that link together

a process that uses heat or chemicals to break long polymer chains into monomer fragments

### 3 Petroleum—A Source of Organic Compounds (continued)

**Define** the terms *fraction* and *distill*. Use a dictionary to help you. Then describe what fractional distillation does to petroleum.

---

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---

**Sequence** the steps in fractional distillation until the first fraction is separated. One step has been completed for you.

1.



2.



3. The hydrocarbons start to turn into vapor. The vapors rise up inside the tower.



4.



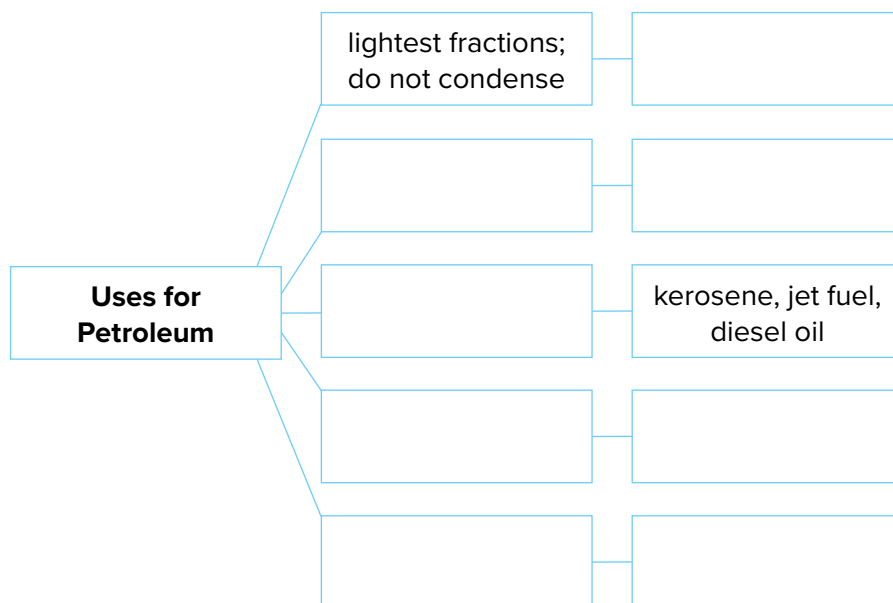
5.

**Model** a fractionating tower. Use the figure in your book for help. Next to the tower, draw an arrow from the bottom to the top. Along the arrow, show where the highest-boiling fractions, middle-boiling fractions, and lowest-boiling fractions condense.

### 3 Petroleum—A Source of Organic Compounds (continued)

**Get It? Compare** the masses of compounds collected at the top of the tower to those collected at the bottom.

**Organize** information about the uses of petroleum compounds. In the middle column of boxes, describe the fractions. In the right column, tell what each fraction is used to make.



**Get It? Explain** how polymers are similar to paper chains.

**Model** a polymer if one paper clip is a monomer.

--

**Describe** at least one benefit and one challenge associated with depolymerization.

Benefit	Challenge

### 3 Petroleum—A Source of Organic Compounds (continued)

#### CHECK YOUR PROGRESS

- 14. Identify** several items around your home that are made from organic compounds obtained from crude oil.

---

- 15. Name** some of the fuels obtained from crude oil by fractional distillation.

---

- 16. Describe** the process of fractional distillation.

---

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- 17. Explain** why polymers made from the same monomer can have physical properties that vary greatly.

---

---

- 18. Describe** why depolymerization can be an expensive process.

---

- 19. Predict** Based on the names of the polymers in this lesson, what do you think the polymer made from the monomer terpene is called?

---

- 20. Math Connection** If the mass of a monomer is 105 amu, find the mass of a polymer containing 122 monomers.

---

# Organic Compounds

## 4 Biological Compounds

### REVIEW VOCABULARY

base

Recall the definition of the Review Vocabulary term.

*base*

### VOCABULARY

protein

carbohydrate

lipid

nucleic acid

deoxyribonucleic acid (DNA)

nucleotide

Use your book to define each term.

*protein*

*carbohydrate*

*lipid*

*nucleic acid*

*deoxyribonucleic acid (DNA)*

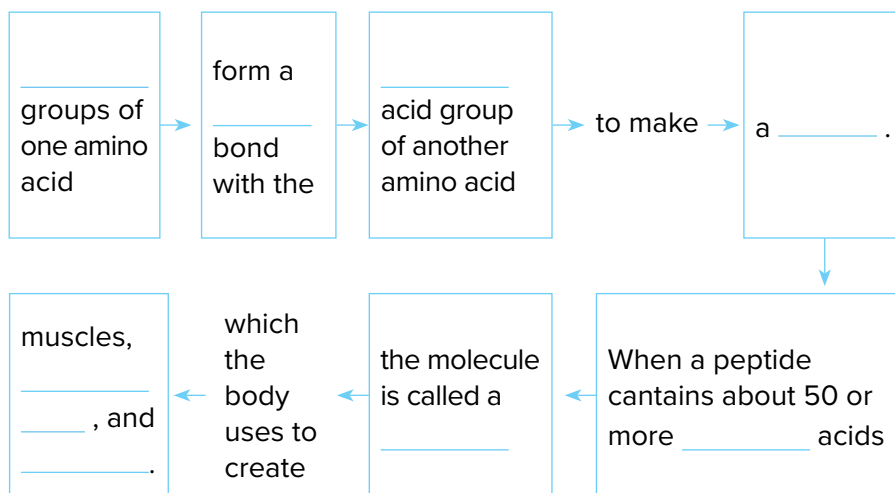
*nucleotide*

## 4 Biological Compounds (continued)

**Compare** and contrast biological polymers to other polymers.

Similarities	Differences

**Complete** the graphic organizer about protein monomers.



**Get It? Explain** what happens when you eat foods containing protein.

---

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**Get It? Describe** the difference between sugars and starches.

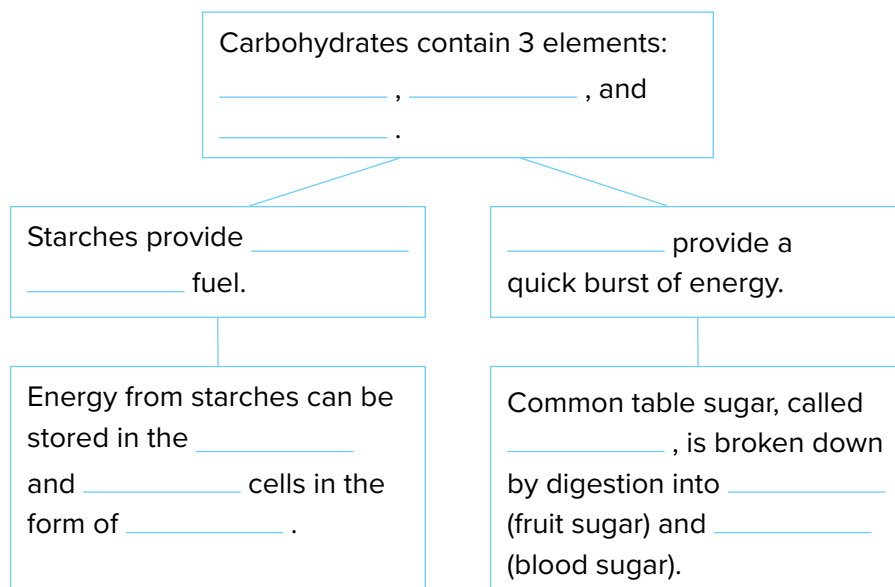
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## 4 Biological Compounds (continued)

**Complete** the graphic organizer about carbohydrates.



**Identify** three lipids.

1. \_\_\_\_\_ 2. \_\_\_\_\_ 3. \_\_\_\_\_

**Contrast** saturated, monounsaturated, and polyunsaturated fats and oils.

Saturated	Monounsaturated	Polyunsaturated fats

**Get It?** **Compare and contrast** the structure and properties of unsaturated fats and saturated fats.

---

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---

## 4 Biological Compounds (continued)

**Get It?** **Compare and contrast** how saturated fats and unsaturated fats can affect human health.

---

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---

**Organize** information about DNA using the table below.

DNA	
<b>Purpose</b>	<b>Structure</b>
<b>Where found</b>	<b>Practical use</b>

**Get It?** **Identify** the three components of a nucleotide.

---

**Describe** ways you could change your diet to consume less saturated fat. Explain what foods you might replace in your diet and why.

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---

## 4 Biological Compounds (continued)

### CHECK YOUR PROGRESS

- 21. Name** the monomers that make up the following biological polymers: proteins, nucleic acids, and starches.

---

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- 22. Identify** where your body gets the compounds that it needs to build proteins.

---

- 23. Describe** the function of DNA.

---

---

- 24. Explain** the difference between saturated and unsaturated fats and oils.

---

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---

- 25. Explain** Whole milk contains about 4 percent butterfat. Explain why you might choose milk containing 2 percent fat.

---

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- 26. Math Connection** You have read that your body is about 15 percent protein. Calculate the mass of protein in your body in kilograms.

---

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# 24 New Materials Through Chemistry

## ENCOUNTER THE PHENOMENON

Write the Encounter the Phenomenon question for this module.

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Use the “What I Know” column to list the things you know about the Encounter the Phenomenon question. Then list the questions you have about the Encounter the Phenomenon question in the “What I Want to Find Out” column. As you read the module, fill in the “What I Learned” column.

K <i>What I Know</i>	W <i>What I Want to Find Out</i>	L <i>What I Learned</i>

# New Materials Through Chemistry

## 1 Alloys

### REVIEW VOCABULARY

alloy

Recall the definition of the Review Vocabulary term.

alloy

### NEW VOCABULARY

conductivity

luster

Use your book to define each term.

conductivity

luster

## 1 Alloys (continued)

**Identify** four advantages alloys may have over pure elements.

1. \_\_\_\_\_
2. \_\_\_\_\_
3. \_\_\_\_\_
4. \_\_\_\_\_

**Create** a journal entry. Imagine you are a jewelry maker or metal worker in ancient or modern times. Write two paragraphs or draw a cartoon strip to tell about your day working with metals. Discuss the metals' ductility, luster, malleability, and conductivity.

**Get It? Describe** how bronze was discovered.

**Get It? List** five examples of items that you know have metallic properties.

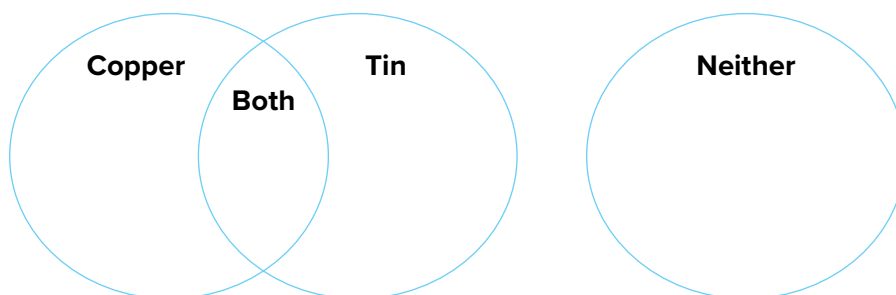
**Get It? Compare and contrast** the properties of gold-copper alloys that are mostly gold with those that are mostly copper.

**Get It? Explain** why steel is an important alloy.

## 1 Alloys (continued)

**Classify** each alloy below as containing copper, tin, both, or neither.

bronze      gold for a ring      solder      tooth fillings  
brass      pewter      sterling silver      wrought iron



**Organize** the properties, uses, and examples of metals and alloys.

Uses	Important Properties	Examples
Jewelry		
Drill bit		stainless steel
		copper
		steel
	low melting point	lead and tin
	malleability	
Aircraft		



## 1 Alloys (continued)

### CHECK YOUR PROGRESS

1. **List** the metallic properties of alloys.

---

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2. **Identify** three different alloys in your home. Describe how each alloy is used and why the properties of the alloy make it suitable for that application.

---

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3. **Describe** the importance of steel.

---

---

4. **Identify** two medical uses of alloys. Describe the desired characteristics in implements made from medical alloys.

---

---

5. **Describe** If you were designing a skyscraper in an earthquake zone, what properties would the structural materials need?

---

---

---

6. **Math Connection** 14-karat gold is 58 percent gold and 42 percent copper. Calculate the actual amount of gold in a 65-g, 14-karat gold chain.

---

7. **Math Connection** If a 7.6-g sample of copper can be hammered into a 2-cm  $\times$  2-cm sheet, calculate the number of grams necessary to hammer a 17-cm  $\times$  17-cm sheet under the same manufacturing conditions.

---

# New Materials Through Chemistry

## 2 Versatile Materials

### REVIEW VOCABULARY

semiconductor

Recall the definition of the Review Vocabulary term.

semiconductor

### NEW VOCABULARY

ceramics

doping

integrated circuit

Use your book to define each term.

ceramics

doping

integrated circuit

## 2 Versatile Materials (continued)

**Complete** the information about the history of ceramic materials by filling in the blanks.

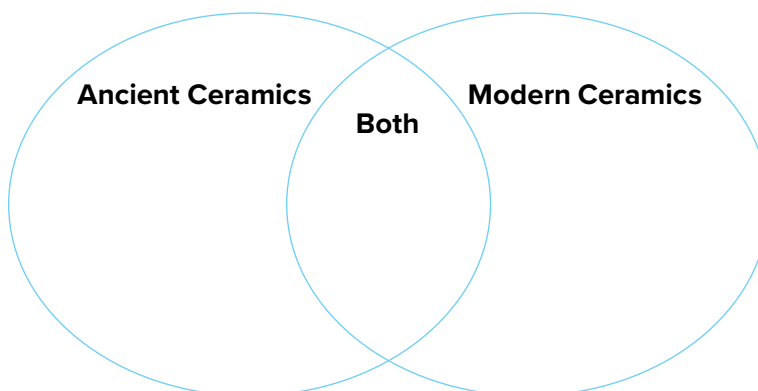
16,000 BC Pieces of \_\_\_\_\_ from this time have been found.

\_\_\_\_\_ BC The first \_\_\_\_\_, called \_\_\_\_\_, was built.

\_\_\_\_\_ BC Walls of towns and homes were made of \_\_\_\_\_  
\_\_\_\_\_ baked in the Sun. \_\_\_\_\_ was first  
used to make cups and bottles.

\_\_\_\_\_ BC \_\_\_\_\_ invented \_\_\_\_\_. Some of their  
structures are still standing today.

**Organize** materials used to make ceramics in the Venn diagram.



**Get It? Summarize** the steps involved in making ceramics.

---

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**Get It? Explain** why ceramics make ideal tableware.

---

---

**Get It? Explain** why ceramics are appropriate for medical applications.

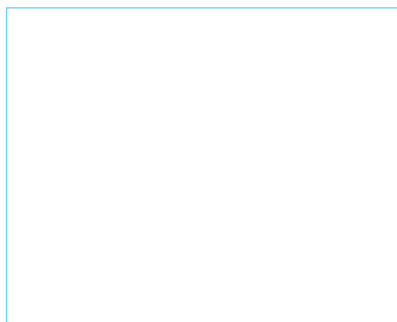
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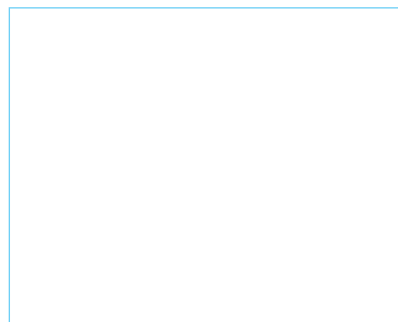
## 2 Versatile Materials (continued)

**Model** the effect of heating on ceramics by drawing ceramic structure before and after firing.

Before



After



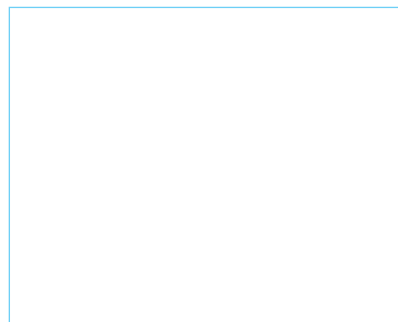
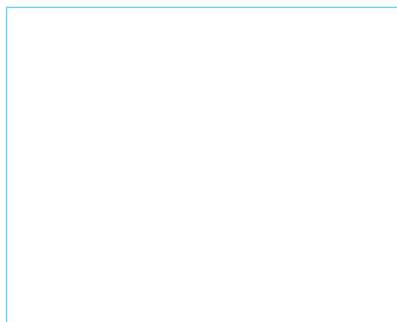
**Get It? Define** the term *semiconductor*.

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**Model** an n-type semiconductor and a p-type semiconductor side by side.



**Contrast** n-type and p-type semiconductors. Explain exactly why the electric current (or electron flow) can only travel in one direction between the two types.

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## 2 Versatile Materials (continued)

### CHECK YOUR PROGRESS

8. **Describe** the electrical conductivities of traditional ceramics, modern ceramics, and semiconductors.
- 
- 
- 
9. **List** five uses of ceramic materials. What properties make ceramics good choices for these applications?
- 
10. **Describe** how modern ceramics are different from traditional ceramics.
- 
- 
11. **Explain** how the function of semiconductors is determined by the electrons and electrical forces between atoms.
- 
- 
- 
12. **Describe** Computers have changed the way businesses operate. If you operated a distribution center for a manufacturer, how would you use computers to assist you?
- 
13. **Math Connection** Ceramic A forms when heated to  $1400^{\circ}\text{C}$  and has a density of  $5.3\text{ g/cm}^3$ . Ceramic B forms at a temperature  $675^{\circ}\text{C}$  cooler and is four times as dense. What temperature is required to form Ceramic B and what is its density?
- 
14. **Math Connection** A developmental ceramic is designed to be 35 percent silica and 65 percent sulfur. If a researcher needs 75 g of this materials, how many grams of each component will she need?
- 
-

# New Materials Through Chemistry

## 3 Polymers and Composites

### REVIEW VOCABULARY

polymer

Recall the definition of the Review Vocabulary term.

polymer

### NEW VOCABULARY

composite

synthetic

Use your book to define each term.

composite

synthetic

### 3 Polymers and Composites (continued)

**Organize** information about polymers in the outline. Fill in the blanks.

#### I. Common Polymers and Their Uses

- A. Polyethylene: \_\_\_\_\_
- B. \_\_\_\_\_ (PVC): \_\_\_\_\_
- C. Polyethylene: \_\_\_\_\_
- D. Polystyrene: \_\_\_\_\_ devices.

#### II. Examples of Natural Polymers

\_\_\_\_\_, \_\_\_\_\_, \_\_\_\_\_

#### III. Useful Properties of Plastics

\_\_\_\_\_, \_\_\_\_\_, \_\_\_\_\_  
\_\_\_\_\_, \_\_\_\_\_, \_\_\_\_\_  
\_\_\_\_\_

#### IV. Synthetic fibers and things that are made from them.

- A. Nylon: \_\_\_\_\_
- B. Polyurethane: \_\_\_\_\_
- C. Polyester: \_\_\_\_\_
- D. Aramids: Fireproof: \_\_\_\_\_;  
Bulletproof: \_\_\_\_\_

#### V. Adhesives and Their Uses

- A. \_\_\_\_\_ : bonds instantly, gets stronger as it dries
- B. \_\_\_\_\_ : used in construction
- C. \_\_\_\_\_ : seal buildings to prevent heat loss
- D. Orthodontics: attach braces to teeth; bond after being exposed to \_\_\_\_\_

#### VI. Surface Coatings and Elastic Polymers

- A. \_\_\_\_\_ : used to protect wood
- B. \_\_\_\_\_ : contain synthetic polymers
- C. \_\_\_\_\_ : used in \_\_\_\_\_, shoe soles, \_\_\_\_\_

### 3 Polymers and Composites (continued)

**Identify** two creatures that produce polymer-like substances and describe a modern material that copied these natural wonders.

1. \_\_\_\_\_

2. \_\_\_\_\_

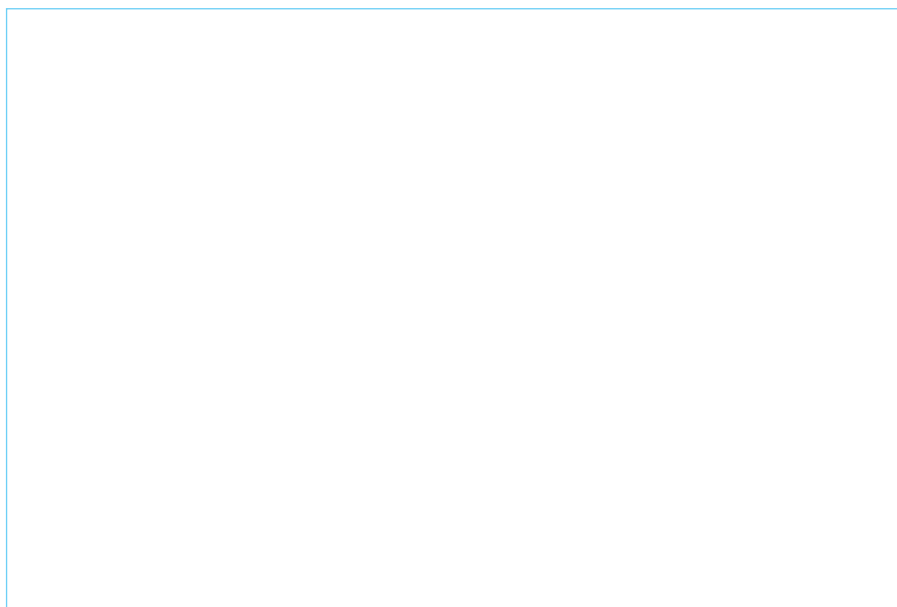
**Get It? Identify** five uses of adhesives.

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

**Create** a concept map to describe fiberglass.



**Get It? Identify** the advantages of using composite materials.

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_



### 3 Polymers and Composites (continued)

#### CHECK YOUR PROGRESS

**15. Discuss** reasons why chemists create new polymers and composites.

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**16. Identify** four uses of synthetic polymers.

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**17. Explain** the difference between natural and synthetic polymers and give an example of each.

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**18. Explain** what a composite material is and give three examples of items that are made from composites.

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**19. Describe** You are designing a new material for use in an airplane body. What properties should the material have?

---

**20. Math Connection** A telecommunications company launches 10,000-kg satellites. A new satellite made from composites promises to reduce that mass by 25%. What is the mass of the new satellite.

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